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Contents for November 17, 1932

VOLUME 109, NUMBER 20

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Planning Rockefeller Center in New York 579

Three Theaters to Entertain Radio City Crowds 583

RCA Building of 69 Stories Rivals Empire State 587

Materials and Structural Elements of Rockefeller Center 590

Skyscraper Plumbing in the RCA Building 593
BY C. MILTON WILSON

Organization and Supervision of Construction Forces 598

Editorials 600

News of the Week 602

New Equipment 608

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Engineering News-Record

Vol. 109 New York, November 17, 1932 No. 20

Large-Scale Group-Building Planning:
Six Articles on Rockefeller Center

Planning Rockefeller Center.....579
Three Theaters to Entertain Crowds...583
The 69-Story RCA Building.....587
Materials and Structural Elements....590
Skyscraper Plumbing 593
Construction Supervision 598

News of the Week..... 602 Editorials ..... 600 Equipment 608

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Planning Rockefeller Center, New York

ROCKEFELLER CENTER, the great three-block building group that is rapidly taking shape in mid-town New York, represents the largest single privately financed construction operation ever undertaken. Of equal note is the fact that here, for the first time, large-scale planning of commercial building groups is producing tangible results in steel and stone. Characterized also as the greatest single real-estate development in history, Rockefeller Center encompasses a dozen buildings, several of which are in the skyscraper class, the largest rising 69 stories and providing more than 2,000,000 sq.ft., or nearly 50 acres, of rentable space under one roof. Obviously such a remarkable innovation in urban development should command widespread attention and analysis.

The mere piling up of a large amount of rentable space on three city blocks is not in itself noteworthy. It has been done before on blocks not far distant from Rockefeller Center. But it has never been done by one owner. Never before has it been done as a single enterprise. And only in dreams and drawings of city planners, architects and engineers has the planning of such an integrated project been subjected to the many group-building planning theories that are the product of the last decade.

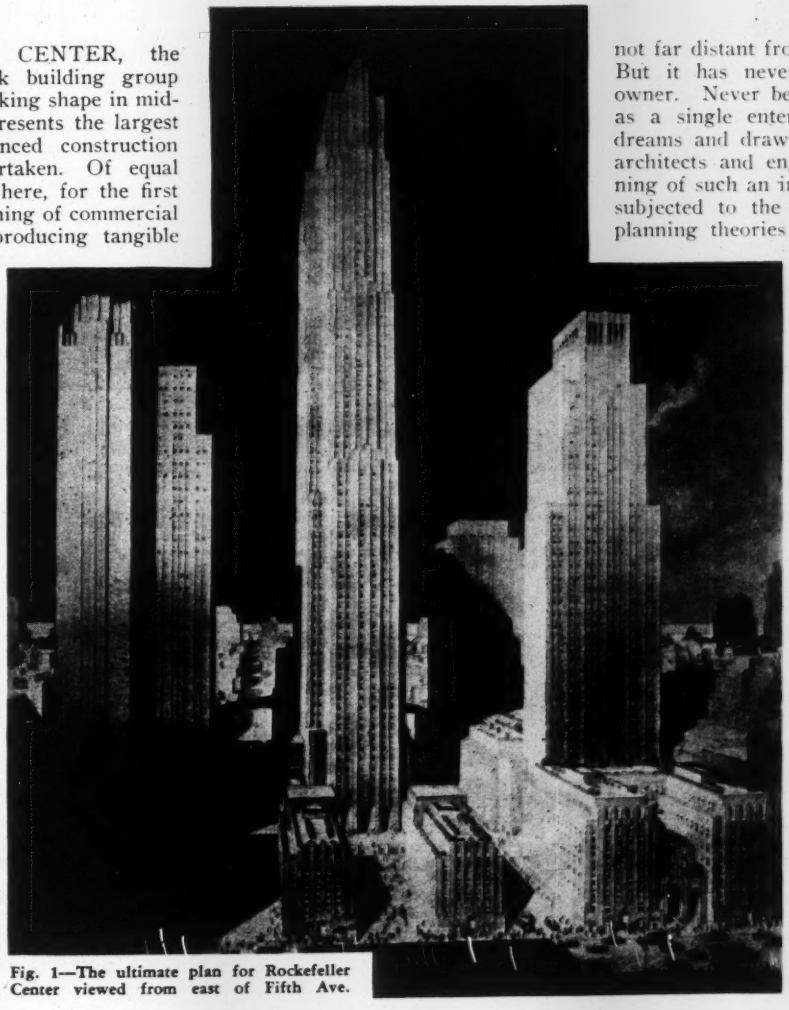


Fig. 1—The ultimate plan for Rockefeller Center viewed from east of Fifth Ave.

It is as a group-planning enterprise, colored to some extent by broader city-planning requirements, that Rockefeller Center is most broadly notable. Built on some of the most expensive land in the world, its success is a matter of vital concern to the ownership and financial interests back of it. Setting entirely new precedents, working on a grand scale, experimenting for almost the first time with the privilege of utilizing every modern material and convenience that science and industry have provided, the architects and engineers responsible for it must measure the

effect of success or failure not alone in terms of their own and their client's interests, but in terms of the future of the building and city-planning arts. That they recognize this broad responsibility is evident both from their specific statements and from the careful and elaborate planning that they are putting into the enterprise. Review of this planning comprises the subject of this article. Following articles take up specific features of the project that are the outgrowth of this planning.

Covering three large city blocks, each 200x 920 ft., between 48th and 51st Sts. and between Fifth and Sixth Aves., an area of 513,000 sq.ft., or between 12 and 13 acres, is contained in the site of Rockefeller Center. The development was first known as Radio City because of the large amount of space contracted for by the Radio Corporation of America, National Broadcasting Co., Radio-Keith-Orpheum Corp. and affiliated companies. This space, destined to be used for theaters, offices and broadcasting studios, is concentrated in the west end of the plot along the Sixth Ave. frontage (Figs. 2 and 3). Recent announcements state that the Fifth Ave. frontage will be occupied by two six-story buildings and two nine-story buildings. The six-story buildings have been leased by French and British commercial interests as offices and showrooms, while negotiations are under way to lease the two nine-story buildings to Italian and German syndicates. Commercial interests in several other countries have been considering space in units yet to be built. Thus, while the west end of Rockefeller Center may be truly characterized as Radio City, the eastern frontage is being developed into something of an international settlement.

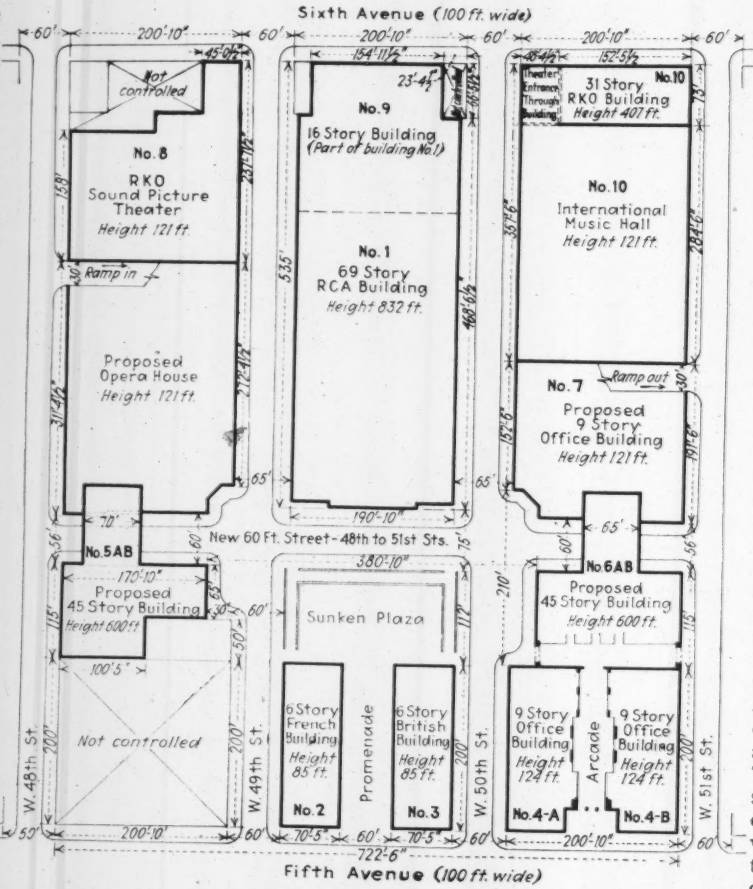


Fig. 2—In the Rockefeller Center layout the tall buildings rising from 400 to 800 ft. above the street are separated by structures about 120 ft. high, assuring permanent light and air. Integrated above ground to the extent that they are grouped around a sunken plaza in the center block and that their roofs are connected by overhead bridges, these buildings are joined below ground by wide, high pedestrian subways. Traffic movement is also facilitated by a new north and south street, by widened sidewalks around the tall building and by wide promenade and arcade entrances to the sunken plaza and the various buildings.

Some general considerations

The plot plan (Fig. 2) shows the fundamental arrangement adopted for the buildings in the group, the skyscrapers being staggered, with relatively low structures between and on the Fifth Ave. front and an open sunken plaza in the center of the central block. Before discussing the reasons for this arrangement and the advantages that it offers, certain general questions bearing on the project require answer.

Through what motivating influence did the embryonic idea of a Rockefeller Center originate? Why was this particular site chosen? What determined the size of the plot? What type of tenancy was contemplated? Will the development change the character of the neighborhood into which it has so suddenly been projected? Will the large population that will occupy the buildings be adequately served by existing transportation facilities or must new facilities be provided?

As may be expected, the answers to these questions were not all determined by simple application of recognized theories. Practical considerations were, in many cases, governing. For example, the plot in the beginning had been selected as the setting for a new opera house. A large site was required, and additional adjacent land had to be controlled if the opera were to be guarded against undesirable neighbors. It was necessary that this land be under one ownership, for it would be impracticable to assemble it from small separately owned parcels. Only one such holding existed in New York City—that owned by Columbia University between 48th and 51st Sts. west of Fifth Ave. Selection of the site, therefore, was not so much a matter of choice as of virtual necessity.

The explanation of how Rockefeller Center emerged as a group of commercial buildings instead of an opera center is found in the early history, beginning about 1928. At that time, John D. Rockefeller, Jr., was asked by certain individuals interested in the opera company (who had tentatively determined to locate the opera house on the west half of the center block of the Columbia University property) to assist them in acquiring the whole block and in addition to donate the east half of the block as an opera plaza or park. The two blocks either side were to be turned over to private interests who would develop them under certain definite stipulations as to type of structure and tenancy. Difficulties arose in the negotiations, and Mr. Rockefeller found himself in possession of most of the three blocks. The opera being out of the picture for the time being, there was urgent need for the property to be improved and made self-supporting. Some sort of commercial development was almost mandatory. This fact is emphasized by the type of lease that Columbia University granted to Rockefeller Center, Inc., the holding company for Mr. Rockefeller. In this lease there is a cancellation and reappraisal clause, which may be invoked at the end of any of the three 21-year periods following the first expiration of the lease in 1952, indicating the concern of the University over the financial success of the project. As a matter of fact, it is much more important that Rockefeller Center should depend upon earnings instead of philanthropy, for if it is to exert any profound effect upon future city growth, its lessons must be applicable to commercial ventures.

Aerial Explorations, Inc.

Fig. 3—Rockefeller Center today, with the buildings facing Sixth Ave. on the west half of the plot (known as Radio City) nearing completion. Construction of the low buildings on the Fifth Ave. front is under way. Demolition of buildings on the east half of the north block (at left) facing St. Patrick's Cathedral has been completed since this picture was taken.

Rockefeller Center was planned from the beginning to serve specific businesses and industries; thus the type of tenancy materially affects the character of its buildings. For example, broadcasting studios require structural layouts quite distinct from general offices. Theaters are in a class by themselves. Offices high above the street are desirable, resulting in the skyscraper, while shopping facilities naturally seek the lower levels and may be accommodated in low as well as high buildings.

The character of the neighborhood into which Rockefeller Center has been put is certain to be changed, for tall office buildings and theaters are introduced into a district in which small shops and homes predominated. Sixth Ave., adjacent to the development, now a business street handicapped in development by the elevated railway, should feel the influence most; and Fifth Ave., already partly a fashionable shopping street and partly a street of high-grade office structures, will be less affected.

Transportation facilities

City transportation systems touch the development on two sides, although neither the Sixth Ave. elevated railroad nor the Fifth Ave. bus line will be adequate when all the buildings are finished and occupied. The proposed Sixth Ave. subway, which will replace the elevated, is counted upon heavily as a transportation medium, but it will be a matter of years before such a subway can be built and opened. The new city subway with a station planned for 53d St. and Fifth Ave., will be the most accessible transportation available when this portion of the system is put into operation. The B.M.T. subway and the West Side branch of the I.R.T. subway have stations within easy walking distance, and all of these rapid-transit lines connect with Pennsylvania Railroad terminal. Grand Central railroad terminal, a quarter of a mile away, has no direct transportation connections with Rockefeller Center. Although present rapid-transit facilities are not ideal, the architects feel that the future will offer a satisfactory solution. Underground tunnel connections with the railway terminals, in which moving platforms might operate, have been considered, but so far such facilities are little more than part of a dream.

Preliminary planning

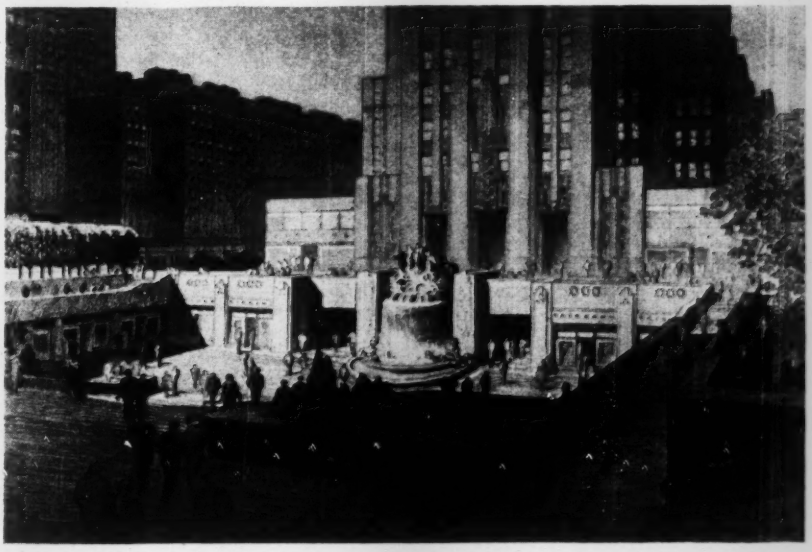
The first plans for a development on this site for the Rockefeller interests were made in 1928 by Reinhard & Hofmeister, who have since become the architects for Rockefeller Center, with Hood & Fouilhoux, and Corbett, Harrison & MacMurray. These pioneer plans were made without knowledge that an opera was to be a part of the development and were more in the nature of a study of a group of office buildings than of a design for such an enterprise as Rockefeller Center has become. (With the exception of an underground roadway loop for truck delivery to the buildings, none of the elements of this early study has been incorporated in the present plan.) Later, when the opera was being seriously considered, a competition was held in which twelve firms of architects submitted plans, but these were all scrapped. The final planning phase, of which Rockefeller Center is the product, began in 1929, with the knowledge that theaters, office buildings and broadcasting studios must be accommodated, and that numerous shops of various types had to be provided for.

An entirely fresh start was made. Many studies were carried out, each firm of architects working separately at first. Later, as the various plans were re-examined, refined and combined, a joint organization was set up. Some of these preliminary studies resulted in unusually novel layouts.

Difficulties with "ideal" layouts

From a theoretical point of view the grouping of numerous buildings on a 12-acre site pointed to a layout with a central hub and radiating streets, after the manner of the street plan of Washington, D. C. But practical considerations again intervened. The two streets that run through the site, 49th and 50th

Fig. 4—The sunken plaza serves not only as the focal point of Rockefeller Center but has the more utilitarian purpose of providing an imposing and easily accessible entrance to the lower shopping level of the 69-story RCA Building in the background. The street-level entrance of the building fronts on the private street.



Sts., had to be kept open. Eight blocks farther north Central Park interrupts cross-town traffic on Manhattan Island, and it was inconceivable that the city would permit another obstruction so near this traffic. Arching the buildings over the streets was considered, but the legal difficulties of securing permission for such unprecedented construction were too great. The net result of some fifteen different studies was the simple layout shown in Figs. 1 and 2.

The plan of Rockefeller Center

In all of the studies a satisfactory earning capacity was the prime consideration, accompanied by the desire to achieve a new blend of beauty and utility in building construction.

The assured presence of radio broadcasting and theatrical interests, with their special requirements and the large population they would employ and attract as visitors, provided the nucleus around which all plans were formulated. This population, which would be available during a large part of every twenty-four hours, would support many shops and restaurants. The greater the population the more valuable the shop sites would become. Beauty and utility would tend to increase both the permanent and the transient population. Accordingly, the basic criteria were laid down that the buildings should be fabricated of materials beautiful in themselves, that decoration more imposing than could be found anywhere else in the world and involving work by famous artists and sculptors should be applied in lobbies and entrances, that roofs be transformed into garden plots, and that every advantage be taken of modern structural and mechanical conveniences. Adherence to these criteria should attract tenants and visitors, thus creating values that could be capitalized.

One of the first modern conveniences considered as necessary was adequate light and air—the whole plot could not be covered with tall buildings. The decision was to spread the skyscraper units as shown in Figs. 1 and 2 and to separate these units by lower buildings, a plan aided by the fact that two theaters were required, in which daylighting was not a prominent factor and which, incidentally, could not, according to New York City building regulations, be surmounted by office buildings. Also a favorable factor to the adopted arrangement is the fact that rental from shop space greatly exceeds that from a similar-sized unit of office space, so that the low buildings will not deprive the owners of as much revenue as would at first be supposed.

The layout of these shopping areas offered another opportunity to create value. Two avenues and four street fronts and the lobbies of the buildings were immediately available. To these the architects first added a subsurface shopping level in the central skyscraper, reached from a sunken open plaza so that it has all of the advantages of a street-level floor. A new 60-ft. private street was cut through the property from north to south, furnishing additional shop frontage. And finally the Fifth Ave. buildings were arranged in pairs with shopping promenades between. In the center block this promenade is 60 ft. wide between the two six-story buildings. In the north block it is planned in the form of a 40-ft. wide arcade four stories high between the two nine-story buildings.

The New York zoning law allows a given plot to be covered with buildings without setbacks to a height of something above 100 ft., depending upon the width of the adjacent street. Above this level towers may rise to any height but must not occupy more than 25 per cent of the area of the plot. The scheme adopted for Rockefeller Center then was in general to cover each of the three blocks with buildings approximately 120 ft. high (with one or two notable exceptions) and then to concentrate the entire tower rights in a few skyscrapers. In the north block one 31-story building and one 45-story building were planned, as shown in Fig. 2. Low buildings, including a large theater, separate these tall structures. An arrangement symmetrical with this north block was planned for the south block, although a certain amount of uncontrolled land makes it impossible to realize this fully. The low buildings in this case consist of a sound-picture theater and the proposed opera house. In the center block the entire tower rights for the 200 by 670-ft. plot west of the private street were concentrated in one 69-story building. By this expedient this tower building could be built without regard to setbacks, which are required when the base of the building covers the entire plot. The Sixth Ave. end of this central block accommodates a sixteen-story office building (actually an integral part of the 69-story building), while on the Fifth Ave. frontage twin six-story buildings are to be erected.

The staggered tower plan of the three blocks gave the offices in the towers a protected outside view, with maximum sight lines, as well as permanent light and air. The effect of open space among the tower buildings is created. The advantages of such a layout are not confined to the development itself but extend to the adjoining property, since it also benefits in the assurance of permanent light and air. In the lower stories of the buildings of the development are concentrated the theaters, broadcasting studios, shops and other types of tenancy that require contact with the street but permit the use of artificial lighting and ventilation.

The staggered tower plan is one of the most important and significant characteristics of Rockefeller Center, for in all previous commercial-building practice skyscrapers covering every available square foot of a plot have been the goal of owner and architect alike. A ratio of cube to area of 15 to 1 has not been uncommon in the 30- to 85-story buildings built in the past ten years. While the individual skyscrapers of Rockefeller Center approximate this figure, the cubage in the development as a whole, which has an average height of only ten stories, is only eight times the rentable area available. If such a ratio can be made to pay (and everyone connected with Rockefeller Center is convinced that it will), an important guide post has been set up for future urban growth.

Although the hub plan of radiating streets was not practical, the layout adopted is in general built around the central block. The actual focal point is the sunken plaza immediately in front of the 69-story building. The principal entrance to this plaza is the 60-ft. promenade between the two six-story buildings on the eastern end of the block, sloping from Fifth Ave. westward to stairs that descend to the sunken garden. From this sunken garden entrance is provided to the first basement level of the 69-story building. The 45-story office buildings planned for the north and south blocks will arch over the new private street, giving the effect of north and south gateways to the focal point of the group.

The traffic problem

One of the most difficult problems for the architects and engineers of Rockefeller Center to solve has been that of traffic. A resident and transient population of about 175,000 persons has to be provided for. Ease of approach from adjacent streets and avenues was important. Free and comfortable communication between all buildings in the group was desirable. To achieve these ends, generous open spaces were provided between the buildings and the new north and south street. By the use of this street, vehicles coming from Sixth Ave. may enter Rockefeller Center and depart without going to Fifth Ave., or vehicles from Fifth Ave. may enter and depart without going to Sixth Ave.

The problem of curb loading has been solved by provision for complete removal of all such traffic from the surface of the adjacent streets. Freight and merchandise entering the project will be discharged in a large area 35 ft. below ground. Vehicular traffic to and from the underground layout will use ramps leading from 48th St. and into 51st St. Tunnels make the distribution of freight and express among the various buildings of the group a simple matter.

For circulation of pedestrians many corridors and passageways have been included 17 ft. below the street level. Freedom of circulation is further facilitated by the wide promenade between the British and French buildings, the

new 60-ft. north-south street, and the widening by 5 ft. of the sidewalks on 49th and 50th Sts. adjacent to the RCA Building. Connections between underground levels and main corridors above will be supplied by elevators, escalators and broad stairs. Thus above ground Rockefeller Center is unified to the extent that it is built around the central plaza. Below ground the unity is actual.

Landscaping

Most of the individual features of Rockefeller Center and of its separate buildings are considered in detail elsewhere in this issue. These include the large two- and three-story broadcasting rooms in the 69-story building, the unique layout of the theaters with shallow balconies and elaborate stage equipment, the huge trusses that form the roof framing of the International Music Hall and the materials and equipment of the units. Brief mention, however, may be made here of one of the most unusual features of the development, which is not touched upon in detail—namely, the landscaping of the roofs.

It is proposed to devote all the lower roof areas to gardens. Special waterproofing provisions have been made in the roof slabs, and the roof framing has been strengthened to carry a load of 3 ft. of earth, 30-ft. trees, shrubs, heavy fountains and statuary. This creation of a suburban setting in a skyscraper group some 125 ft. above the street is a distinct innovation and is in line with the attempt to create additional value in the development. It removes the dismal view of flat bare roofs now seen from all tall buildings and is counted upon to draw many tenants into the surrounding towers. Also an admission charge to the gardens is contemplated, so that their cost will not have to be absorbed by the tenants in rent. Bridges are planned to be built across 49th and 50th Sts. connecting all of the gardens into a unit.

Most of the gardens, with the exception of those in the sunken plaza, will be visible only from above. However, a recent change in plans, providing for the two nine-story buildings on the Fifth Ave. front of the north block, includes a garden plot that should serve the man in the street. The roof of the arcade between these two buildings is to be terraced, starting from about the second-story level, and these terraces will be covered with landscaping similar to that used elsewhere.

In many respects roof decoration is much more important than façade decoration, upon which vast amounts of energy and money have been expended in the past, for a much greater area of roof than of façade is visible from the windows of tall buildings. The experiment with roof gardens in Rockefeller Center should provide valuable data for future urban building planners.

The plan is flexible

Rockefeller Center is not yet a finished project but one that is continually developing. Although adhering to certain basic concepts, the plan is flexible and is constantly changing as new tenant requirements become known. The buildings so far built are inclosed with Indiana limestone, aluminum spandrels and a granite base. No projecting cornices are used. All future units will conform to this same simplicity of appearance.

Administration

Rockefeller Center is being built by John D. Rockefeller, Jr., through Rockefeller Center, Inc. The firms of Todd, Robertson & Todd, and Todd & Brown are in charge of the project for this company. The architects are Reinhard & Hofmeister, Corbett, Harrison & MacMurray and Hood & Fouilhoux. Structural design has been carried out by H. G. Balcom & Associates. Clyde R. Place is in charge of the mechanical engineering work in the development.

Three Theaters to Entertain Radio City Crowds

Aggregate seating capacity over 13,000—Largest of three exceeds size of any yet built, includes numerous innovations and an unusual assembly of huge trusses

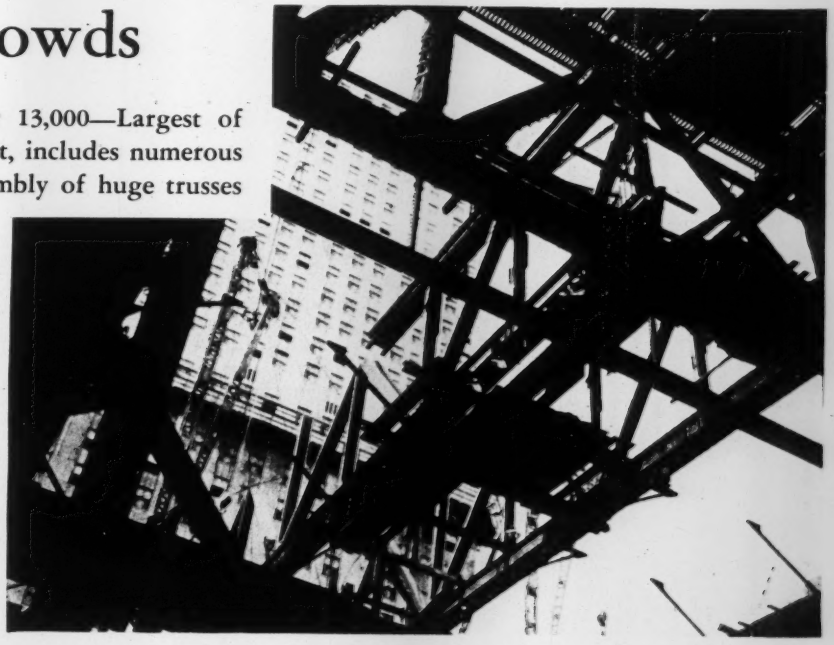


Fig. 1—Some of the bridge-type trusses that span the auditorium of the International Music Hall. View taken from stage looking toward Building No. 10 shows the proscenium truss overhead and the two center longitudinal trusses. Only one-half the span of the latter trusses is visible, the support at the far end being a falsework tower.

AMONG the eleven buildings on the three-block site of Rockefeller Center are three theaters for as many different types of entertainment. Two of these halls of entertainment are in Radio City—the separate name given to four buildings on the western side of the development—and the third is immediately adjacent thereto. Located between the towering structures of this skyscraper city, these relatively low buildings of eight and ten stories will assure the permanence of open spaces that are necessary for light and air in a group development of this kind. Their roofs, landscaped with trees, shrubs, walks and fountains, will serve as lawns for the tenants of the taller buildings, and with their aggregate seating capacity for over 13,000 persons, the theaters will contribute notably to the entertainment facilities of the center. In basic plan they introduce several innovations into the theater field, and structurally they include notable assemblies of roof trusses and cantilever balcony girders.

The plot plan, page 580, shows two theaters and a proposed opera house. Theater No. 8, known at present as the Sound Theater, will be devoted entirely

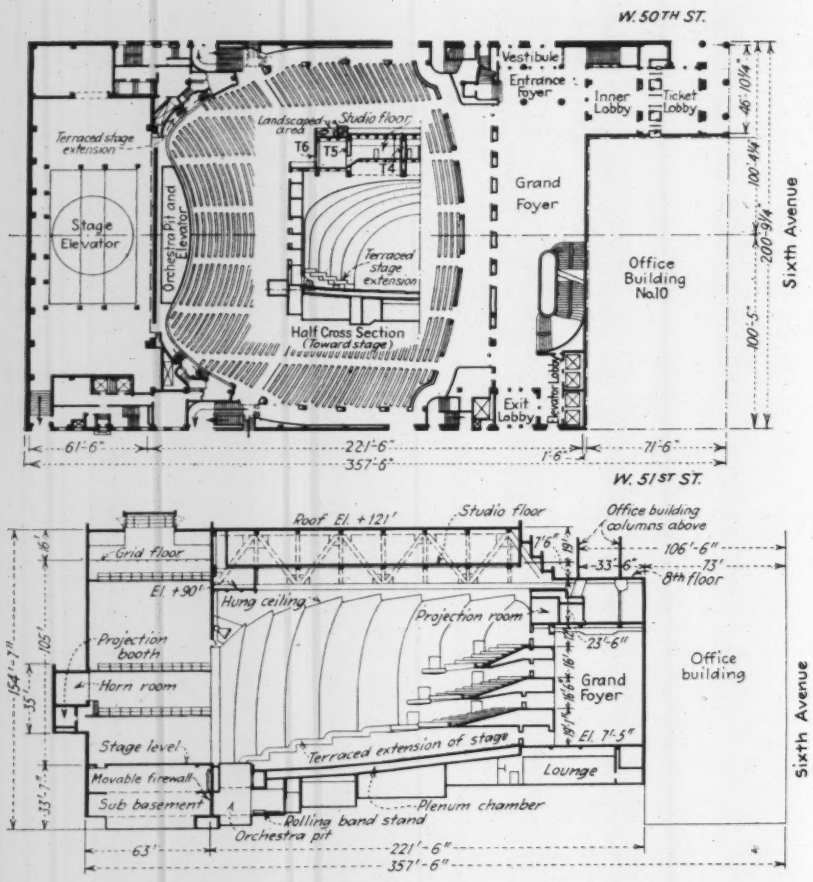


Fig. 2—International Music Hall (Theater No. 10) sets new precedents in theater construction with a three-section stage elevator, terraced extension of stage around side walls of auditorium, orchestra platform which may be transferred to stage, and shallow balconies. Seating some 6,000 persons, it is claimed to be the largest theater yet built, and it incorporates in its roof framing an unusually heavy assembly of steel trusses. Landscaped roofs are features of all of the theaters in the group.

to motion pictures. Theater No. 10, known at present as the International Music Hall, is, structurally, a part of the 31-story R.K.O. Building, designated on the plot plan as Building No. 10. The International Music Hall will be devoted principally to pageantry and large spectacle productions similar to those formerly featured at the old Hippodrome on Sixth Ave. Both theaters have been leased and will be operated by the Radio-Keith-Orpheum Corp. In structural interest neither the Sound Theater nor the proposed opera house is unusual, although both are comparatively large.

The auditorium of the Sound Theater, which will have a seating capacity of something over 3,500, is about 160x200 ft. in plan and is spanned by six roof trusses, ranging from 120 to 128 ft. long, with their bottom chords about 80 ft. above the auditorium floor. Three shallow balconies extend in a semicircle around the rear of the auditorium.

Although the main body of the theater structure is located between 48th and 49th Sts., only its entrance lobby, about 45 ft. wide, extends through to Sixth Ave.

Opera house planned

The proposed opera house is located near the center of the block between Fifth and Sixth Avenues, 48th and 49th Sts. The site reserved for it has a frontage of 311 ft. on 48th and 49th Sts. and about 200 ft. on a new street running from 48th to 51st Sts., parallel to and about 315 ft. west of Fifth Ave. According to present plans the main entrances to the opera house will be located on this new street. The floor of the main auditorium will be one story above the street level. Placement of all service features on the street level makes possible an immense auditorium and a clear stage about 200 ft. wide and 82 ft. deep—larger than that of any other opera house in the world. The auditorium proper will accommodate 4,300 persons.

A 6,000-seat theater

The International Music Hall is the structure of most commanding interest. Seating more than 6,000 persons, it takes first rank over the Roxy Theater in New York as the largest in the world. Contrasted to the complexities which characterize the Roxy Theater framing, this theater is relatively simple structurally, but it surpasses any theater yet built in the massiveness of its roof trusses. For example, spanning lengthwise of the auditorium are four trusses 173 ft. long between supports and weighing about 225 tons each, while the truss above the proscenium opening has a 110-ft. span and weighs 300 tons, if the two members at either end (the vertical over the point of support and the extension of the top chord to meet it) required to complete the rectangle are included. Available records indicate that a truss in the Ambassador Theater in St. Louis with a 126-ft. span and weighing 277 tons was previously the heaviest steel truss used in a theater. Other large building trusses are in the Stevens Hotel, Chicago, span 86 ft., weight 240 tons; Roxy Theater, New York, span 103 ft., weight 200 tons; and Paramount Theater, New York, span 121 ft., weight 150 tons.

In plan, the International Music Hall is about 200 ft. wide by 285 ft. long on 51st St. and 358 ft. long on 50th St. The theater proper (stage and auditorium) is 284½ ft. long, the entrance lobby 73 ft. long and 48 ft. wide, occupying part of the first three floors of Building No. 10. Thus, structurally, the 31-story office building and the theater, as shown by the plot plan, p. 580, are a single unit.

Shallow balconies

The theater involves several new concepts in planning which affect the structural design. Previous large theaters have included deep balconies extending far out over the orchestra floor, dividing the audience into two distinct units. In order to eliminate this separation, the three balconies in this new theater are made relatively shallow and are cantilevered from the rear wall so that no supporting columns are required in the auditorium floor. The stage, 60 x 144 ft. and 105 ft. high from stage level to gridiron floor, also incorporates several innovations. By a series of steps and landings it is extended around each side wall of the auditorium to meet the lowest balcony.

Three-section stage elevator

In the center of the stage proper is an elevator 45 ft. wide and 70 ft. long divided lengthwise into three sections, each about 14 ft. wide and each set on two plungers. The holes for these plungers are 3 ft. in diameter and 54 ft. deep, in solid rock. The elevator may be raised to a height of 14 ft. above the stage, and by raising the sections to different elevations a terraced stage may be produced. A turntable is also incorporated in the elevator and, with all sections of the elevator at the same level, where they are locked automati-

cally, the turntable may be operated in either direction.

The floor of the musicians' pit is also built on an elevator which may be raised to stage-floor level, thus increasing the size of the stage. It may also be dropped below the stage floor where an opening, shielded by a movable, rigid, asbestos fire curtain is provided under the stage area (Fig. 2).

Mobile orchestra

The musicians in the orchestra are seated on a movable platform or truck called a "band wagon." On this platform the entire orchestra, comprising 75 musicians, may be moved onto the stage elevator (in its lowered position) and then raised on any one of the three sections to any point desired. This "band wagon" will be operated by storage batteries carried on the platform itself. This mobile orchestra is an entirely new feature in theatrical presentation.

Fig. 3—Among the notable structural details of the International Music Hall are heavy roof trusses, large-section columns and three tiers of long cantilever balconies, with each of the two upper balconies carried on the anchor arm of the balcony below. The foyer of the theater undercuts the lower six stories of a 31-story office building. The tops of the columns in the transverse lines under the orchestra floor are at the same elevation, made possible by placing them on curves following lines of equal elevation on the orchestra floor. Heavy roof framing is provided between the two center trusses to carry three fountains spaced as desired, although these fountains are not planned to be included in the initial landscaping.

Stage framing

Of the framing in the stage portion, the back wall and the girder required under the front of the stage floor to span the opening through which the "band wagon" is moved are notable. In the back wall, columns unsupported for a height of 115 ft. above the stage are required; stiffness parallel to the web and not load capacity being the special necessity, 30-in. girder beams set on end are utilized. Outrigger frames of angles are attached to these columns at several elevations in their 115-ft. height to stiffen them transversely to the web. At stage level they are braced by a horizontal truss whose end reactions are carried into the stage-floor framework. The girders under the front of the stage are made up of two 60-in. plate girders separated 6 ft. 10 in. by means of struts and horizontal bracing in the planes of the top and bottom chords. The girders have a span of 70 ft. An understage passageway is carried below these girders by double-angle hangers.

Special structural features

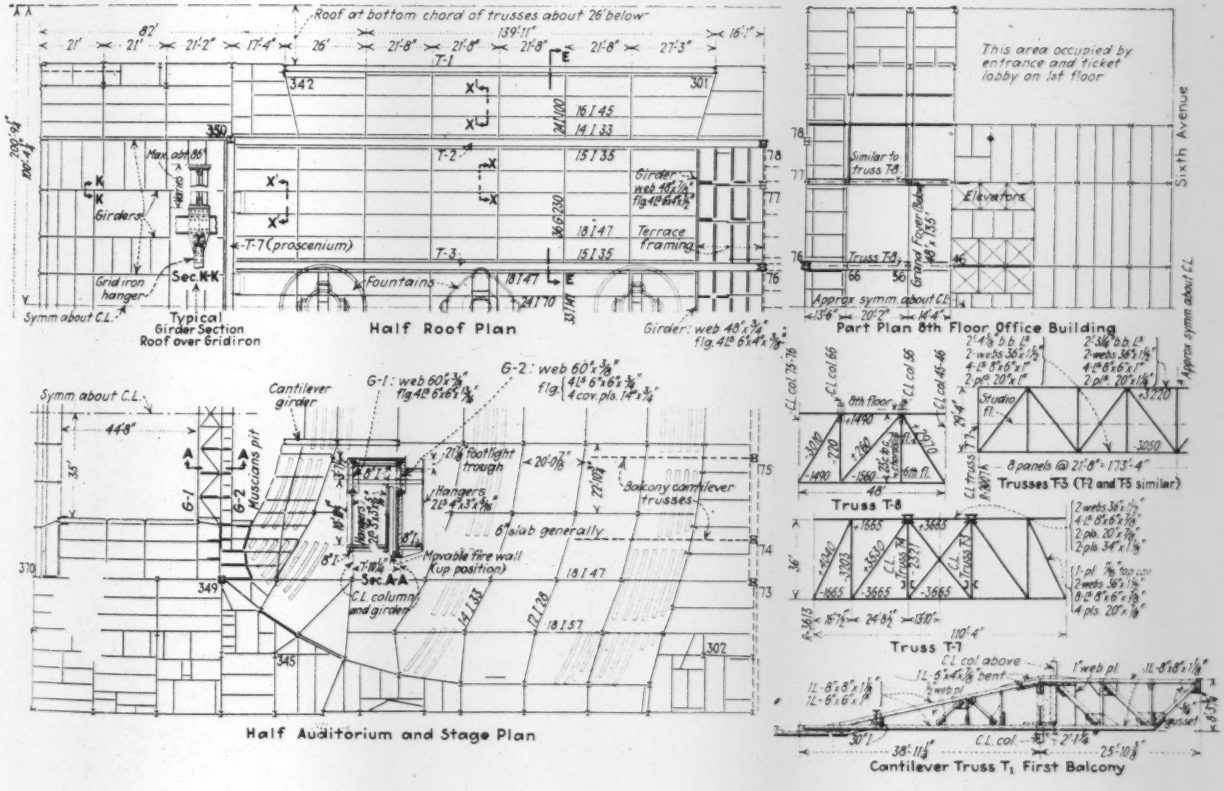
Under the auditorium floor columns are lined up longitudinally, parallel to the building center line but, transversely, follow the circular arcs corresponding to the rows of seats, as shown in Fig. 3. This arrangement places the tops of all columns in a transverse row at the same height, whereas a square grid layout would have required all columns to be of different lengths.

The three balconies that extend in a curve around the rear of the theater are notable first for the long cantilever arms (the longest being about 43 ft.) and second for the stepped arrangement of the fulcrum columns. By progressively stepping these columns backward (Fig. 2) the load of the balcony above is brought onto the anchor arm of the balcony below, reducing the uplift on the anchor arm and lessening the bending moment on the cantilever.

The rear ends of the anchor arms are attached to heavy columns that support the roof trusses over the auditorium. These columns also carry the trusses that span the grand foyer which occupies space in the office building, about 48x135 ft. in plan dimensions and 60 ft. in clear height. These trusses over the foyer, of which there are four, have a span of 48 ft. and are located between the 6th- and 8th-floor levels. Each truss carries two building columns extending to the top of the office building 23 stories above. One interesting structural detail in the foyer is embodied in the stair girders of the grand staircase. These are 18-in. plate girders of 40-ft. span, bent near the middle to accommodate a landing. No supporting columns are required, the bottom ends of the girders resting on a floor beam and the top ends resting on framing cantilevered out from the first balcony floor.

Roof trusses

The system of roof trusses over the auditorium comprises the most notable



structural feature of the theater. Briefly, it is made up of a proscenium truss of 110-ft. span and six longitudinal trusses, the four interior trusses having spans of 173 ft. and the two outside trusses spans of 140 ft. Of the four 173-ft. trusses, two are carried at the east end by the proscenium truss and two are framed into the same columns that support the proscenium truss; these columns thus carry the proscenium truss and one-half the load from the four 173-ft.-span longitudinal trusses. At the west end, the longer trusses are carried by columns in the wall between the auditorium and the grand foyer in the office building; two of these same columns also carry trusses over the foyer. The shorter trusses over the auditorium are carried on independent columns at both ends, located about 20 ft. inside of the north and south walls of the theater. The depth center to center of chords of the proscenium truss is 36 ft., of the long longitudinal trusses 29 ft., and of the shorter longitudinal trusses 26 ft.

The individual members of trusses of such span, in a layout of this kind, need to have substantial sections to carry their own weight and that of a normal roof load, but in this building the sections are even larger because of special roof requirements. Thus, provision was made in the design for the roof between the two outside trusses on either side to be loaded with 36 in. of earth and trees, shrubs and sidewalks, making the total load 450 lb. per sq.ft. The remainder of the roof was designed for somewhat lighter loads of earth and trees, except for the strip between the two center trusses which, in addition, was planned to carry three fountains located as desired. In addition to these loads a framing of double channel members is hung below the trusses to carry the architectural ceiling, and a studio floor is carried about 12 ft. above the bottom chords of the longitudinal trusses, designed to support a 75 lb. per sq.ft. live load. In the studio floor several rooms about 75 ft. long, 40 ft. wide (between trusses) and 16 ft. high are provided for rehearsal and broadcasting purposes. The make-up of the members of the trusses is given on Fig. 3.

Col. No.	MAXIMUM SECTION Core	Cover Plates	Web Plates	MAX. LOAD (Kips)
73	14 H 426 5 x 5 x 1 L⁸	2-30 x 1 15/16		4,116
75	14 H 426 8 x 6 x 1 L⁸	2-32 x 3 5/8		5,872
76	do	do		do
78	14 H 287 5 x 5 x 1 L⁸	2-30 x 1½		3,104
342	14 H 384	2-18 x 1		2,232
345	14 H 426	2-18 x 1		2,408
349	14 H 320 8 x 6 x 1 L⁸	2-36 x 3 5/8	2-16 x 2 13/16	7,489
350	do	do	2-16 x 2 5/8	7,218
370	30 G 200	2-16 x ¾		1,248

Fig. 4—Heavy column sections used in the International Music Hall utilize H-section cores and cover and web plates as required. Columns 75 and 76 carry trusses over foyer as well as longitudinal trusses over the theater. Columns 349 and 350 carry proscenium truss and one-half of load from four long trusses over auditorium. Column 370 is typical of columns in east wall, back of stage.

Truss design

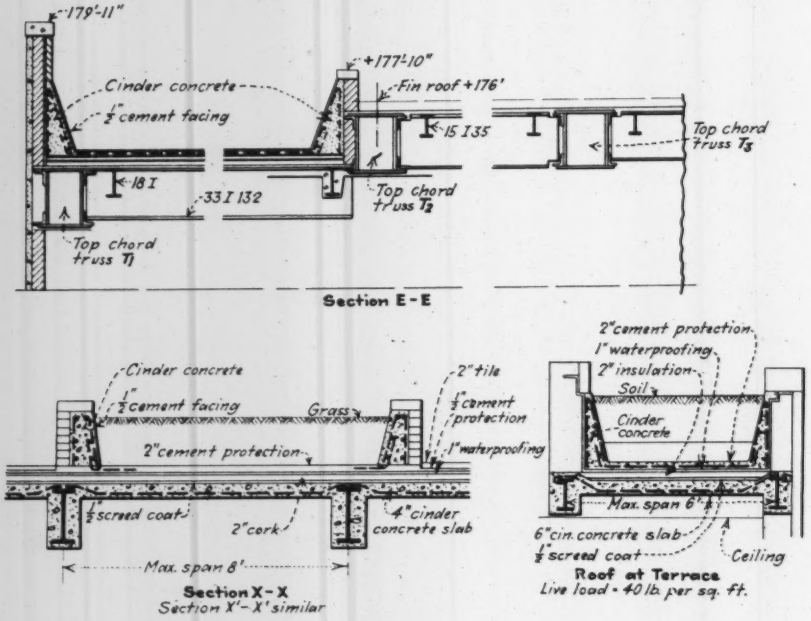
No special difficulties were encountered in the design of the trusses. The longitudinal trusses are relatively fixed at the west end where they frame into the office building, so that chord lengthening probably is accommodated at the proscenium truss end. The maximum theoretical movement is about ½ in., which is not excessive for the proscenium truss to take in transverse deflection nor for the supporting columns under the proscenium truss to take in bending, considering their length of nearly 100 ft. A camber of 1½ in. was provided at the center of the proscenium truss, while 2½ in. was required at the center of the longitudinal trusses.

Large columns

Heavy columns are required to support this truss assemblage. All of the columns are built up from H-section cores, utilizing angles, web and cover-plates, as required and noted in Fig. 4. The heaviest loads are carried by the proscenium truss columns, which sustain 7,489,000 and 7,218,000 lb. respectively. The loads on the two columns in the wall between the auditorium and the grand foyer that carry both auditorium and foyer trusses average about 5,900,000 lb.

Special roof slabs, protected by waterproofing, and parapet walls treated in the same manner (Fig. 5) are required on the roofs because of the contemplated landscaping. The terraced area, dropping down from the theater roof to the setback along the east wall of Building No. 10 at the 8th-floor level, is also designed to accommodate landscaping.

Fig. 5—Waterproofed troughs on the roof of the International Music Hall are typical of those provided on the roof of all low buildings in the development to provide areas for planting trees, shrubs and grass. This landscaping results in a maximum live load of about 450 lb. per sq.ft. so that exceptionally heavy roof framing is necessary. Sections are noted on Fig. 3.



Special theatrical devices

Of the many new and special theatrical devices the stage elevators have already been mentioned. In the center of the turntable on these elevators an opening will be provided for a fountain or other water effects. Seven feet back of the main proscenium opening will be a second portal, the rectangular opening of which may be adjusted in a manner similar to that used with a camera shutter. Thus stage openings from 100x60 ft. down to the size of a small door may be produced.

Lighting will play a prominent part in the stage productions, much of the stage light being provided from four motor-operated light bridges 104 ft. long. The back stage wall is faced with white enameled brick, as a reflection medium. Thunder, wind and other sounds may be produced from a sound projection booth in the rear of the stage. At the rear of the stage also will be a canvas-covered steel and wood cyclorama, 113 ft. wide by 73 ft. high, serving as a sounding board and equipped with lighting apparatus which can produce formations of stars, clouds and other natural effects. This cyclorama, weighing 15 tons, is raised electrically whenever the sound projection booth is being used.

Personnel

The structural design of the theaters was made by H. G. Balcom & Associates, with H. R. Hjorth in charge. The general contractors are John Lowry, Inc., for the International Music Hall, and Barr, Irons & Lane, Inc., for the Sound Theater.

RCA Building of 69 Stories Rivals Empire State

Both steel tonnage and rentable area greater than in world's tallest structure—Absence of setbacks characterizes tower—Large two- and three-story rooms in broadcasting studio section—Structural design including wind methods reviewed

THE main building of the Rockefeller Center group is a notable structure and forms a fitting climax to half a decade of super-skyscraper construction which, with this one exception, was abruptly brought to an end by the business depression that began in 1929.

Rising 69 stories or 832 ft. from the street, the RCA Building compares favorably with the Chrysler, Cities Service and Manhattan Company buildings in New York, whose extreme heights of 1,045, 950 and 925 ft., respectively, depend upon tapering towers and tall flag poles, while the RCA Building is topped out flat. Although its roof is 211 ft. below the elevation reached by the main body of the Empire State Building and over 400 ft. below the top of the observation tower on this structure, in rentable space the RCA Building is said to exceed the world's tallest structure; the respective totals are 2,100,000 and 2,073,947 sq.ft. Another size comparison may be made by referring to the steel tonnages of some of the larger buildings. In such a comparison the 58,500 tons of the RCA Building slightly exceeds the 57,000 tons required in the Empire State. In the Cities Service Building the steel tonnage is 24,000, in the Chrysler Building 21,000 and in the Manhattan Company Building 18,500. The only other building yet built which has required in excess of 50,000 tons of steel is the Merchandise Mart, in Chicago, a low but widespread structure.

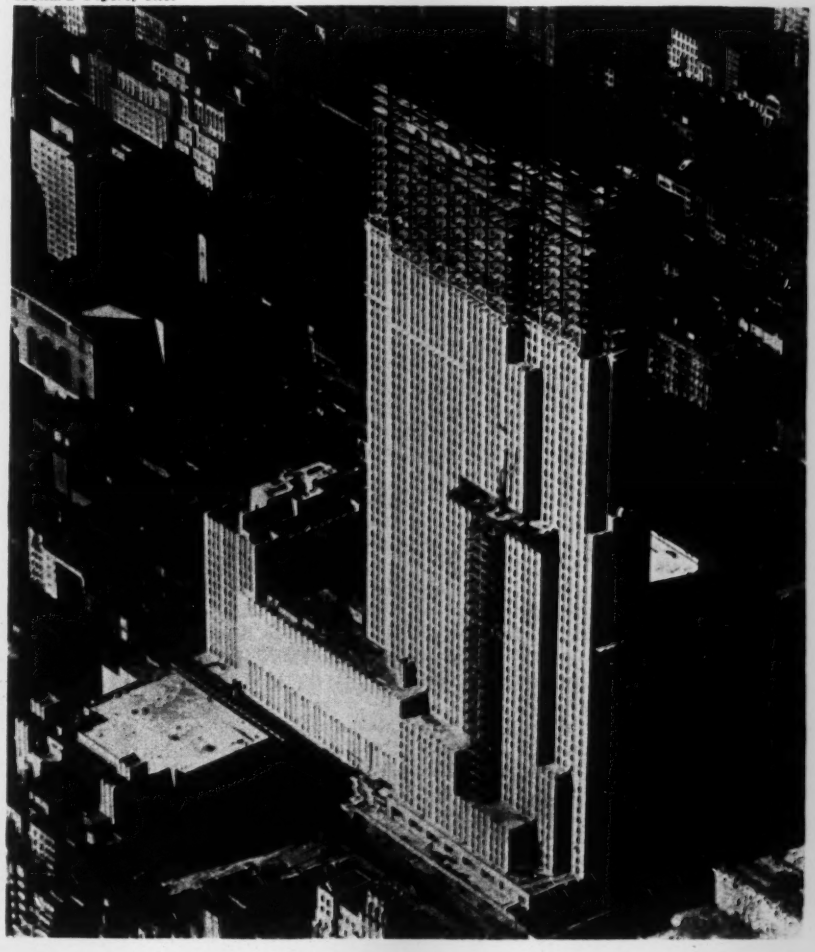
The basic design of the RCA Building is unprecedented among modern New York skycrapers, for the form of its mass is not materially affected by building-code requirements. Whereas other skyscrapers necessarily rise in a series of steps and setbacks to a central tower, the RCA Building rises almost sheer from the street. The setbacks that do occur were planned for purely architectural reasons or to eliminate dark corners, far from the windows, caused when elevator banks are stopped off. This apparent disregard for the building code, which requires a setback after an unbroken rise of about 120 ft. to a tower that covers only 25 per cent of the ground plan, was made possible by concentrating all of the 25 per cent tower rights on a 200x670-ft. plot in a building with base dimensions of only 200x535 ft., leaving the remainder of the plot unoccupied. The tower is 103x327 ft. in plan.

The main or tower section of the RCA Building is long and narrow—its form resembling a narrow slab set on edge—with the long axis east and west. Fig. 1, which is a recent air view, indicates how the tower portion of the building is surrounded on three sides, north, south and west, by what is, in effect, a secondary U-shaped building rising in steps from east to west and giving the impression of buttressing the slab-shaped tower, thus lending to it an appearance of greater stability.

In the layout plan of Rockefeller Center, on page 580, the RCA Building is designated as RCA Building Section Nos. 1 and 9. It is actually a single structure 535 ft. long and 191 ft. wide at the base. Section No. 1 comprises the tower and the stepped "buttress" areas rising to the 12th floor on the north and south. Section No. 9 covers about the west third of the 535x200-ft. plot and contains a 16-story office wing on the Sixth Ave. frontage and a 12-story radio broadcasting studio unit situated between the 16-story and the 69-story section of the building. Considering the RCA Building as two sections, Nos. 1 and 9 were matters of construction expediency, since the structural and architectural characteristics of each section are quite different. Structurally, section No. 1 is typical of tall office-building construction and is characterized by an unusual simplicity in its framing, although presenting some innovations in plan layout and wind

Fig. 1—The RCA Building, central unit of Rockefeller Center, is notable for its slab-shaped tower, about 100x325 ft. in plan. The low central section, devoid of windows, houses broadcasting studios. The total ground plan of the building is 200x535 ft. Note steel relay platform about half-way up face of tower. Picture was taken from a height of 2,200 ft. on the day that steel was topped out. Note Sound Theater in left foreground.

Monard Flyers, Inc.



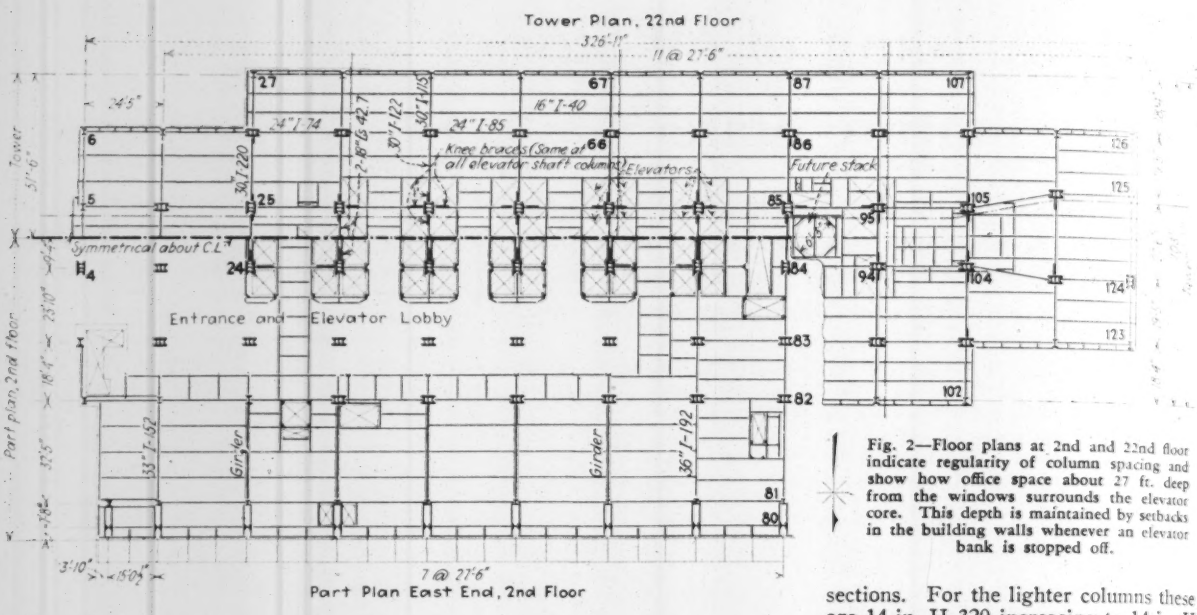


Fig. 2—Floor plans at 2nd and 22nd floor indicate regularity of column spacing and show how office space about 27 ft. deep from the windows surrounds the elevator core. This depth is maintained by setbacks in the building walls whenever an elevator bank is stopped off.

design. In section No. 9, on the other hand, the large spans required in the broadcasting studios made the use of heavy girders and trusses mandatory. The special requirements of radio broadcasting also created numerous unique architectural problems in this section of the building.

The RCA tower

Section No. 1 is built around the elevators that occupy the core of the tower, being set in banks of four, backed up against the north-south column lines. The basic plan provides for a 27-ft. depth of office space from the windows to the corridor around the elevators, this depth being assumed to be the maximum to which adequate daylight will penetrate from windows in a story 11½ ft. high. This 27-ft. depth is constant throughout the tower and is maintained in the upper area, where the discontinuance of elevator shafts would create more floor space, by cutting back the building walls. The setbacks along the north and south faces of the tower, therefore, reveal the elevations at which various elevator banks are dropped off. The setbacks along the east face of the tower assist in keeping the depth of office space in this area to a reasonable figure, but fundamentally they are architectural rather than functional.

The framing plan is simple. Columns are lined up in both directions. In the east-west bents they are spaced 27½ ft. on centers as the optimum for window installation and as adequate to accommodate two rows of elevators and a 10½-ft. corridor between. In the north-south bents the column spacing is not uniform, due to the elevators. These north-south bents, being relatively shallow, are critical as far as wind resistance is concerned, and it was, therefore, desirable to concentrate column steel and heavy bracing near their centers. The two center columns are spaced 18 ft. 8 in., and beams framing into them on all four sides are braced with story-high knee-braces placed in the elevator shaft walls. The next panel of the bent is 23 ft. 10 in. and the outside panel 18 ft. 4 in., span lengths which were fixed partly by permissible beam sizes and partly by the requirement of the 27-ft. office depth. In general, these span lengths continue through the building unchanged. However, the 18 ft. 8-in. center panel is widened to 27 ft. 6 in. at the west face of the tower in order to accommodate the same number of windows as used on the north and south faces; at two panels farther west, in section No. 9, this span is again increased to 30 ft. to provide a wide foyer between the broadcasting studios.

Typical framing of section No. 1 is shown on the plan, Fig. 2. Foundations are of the type well established for tall buildings. All footings are on rock. For the lighter column loads steel billets carrying the columns are embedded in the concrete. For somewhat heavier loads the billets are placed on a grillage of I-beams also embedded in the concrete. In each instance the column is fastened to the billet by clip angles. On the heaviest loaded columns, a wing-plate base is used in which the wing plate, a billet set on edge, replaces the cover plates on the bottom 4 to 8 ft. of the column. The joint between the wing plates and cover plates is milled to bear. In the largest of these bases, under cols. 84 and 85, grillage beams are 24 in. I-120 reinforced on the webs with 1⅜ in. of plates, either side; the billet is 46x6x164 in.; and the wing plates are 8 ft. high, 3½ ft. wide at the top spreading to about 14 ft. wide at the base, and 3⅞ in. thick.

Column make-up is based on rolled H-sections. For the lighter columns these are 14-in. H 320 increasing to 14-in. H 426, with cover plates added as required. For the heavy loads in the central part of the tower three-web columns are used consisting of an H-section core and two side webs attached between the H-section flanges, Fig. 3. The heaviest of these is col. 83, carrying a load of 9,435 kips. It is composed of a 14-in. H 320, two outer web plates 16x3⅞ in., four 8x8x1⅛-in. angles and two cover plates 42x4⅛ in.

Future power plant

A boiler room is provided in the basement as insurance against a raise in utility service charges. In connection with this boiler room, provision had to be made for a stack which would have to extend through the roof of the tower. The location chosen for this stack is in the area bounded by cols. 84, 85, 94 and 95, and at some future date these columns may have to carry the very considerable load of steel plates in the stack. Calculations showed the total load at the bottom would be about 11,900 kips on one pair of columns and 11,300 kips on the other pair. In carbon steel the practical limiting load on three-web columns was about 9,500 kips, because

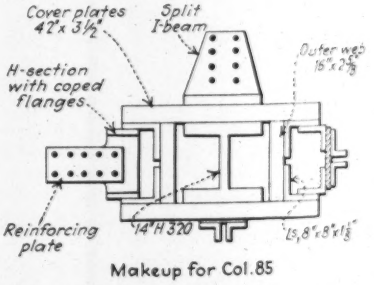


Fig. 3—Wind connections and column make-up in RCA tower. The largest three-web column carries a load of about 9,500,000 lb.

such a column required 4⅛ in. of cover plates which, with the 2-in.-thick flange of the H-section core, necessitated a rivet grip of 6⅛ in.; the maximum grip permitted was 6½ in. or five times the rivet diameter of 1¼ in. Accordingly, a five-web carbon steel column or an alloy steel column in which a higher working stress could be used was required for these four columns. The fabricator chose to use silicon steel in the three-web design, and cols. 84, 85, 94 and 95 are of this material from the 13th floor to the bottom. It is in this length that the load exceeds 9,500 kips. Above the 13th floor, where the load is smaller, carbon steel is utilized.

These four silicon steel columns were fabricated ⅜ in. longer per story than the carbon steel columns that surround them because of their greater shortening under load. This theoretical difference in shortening, it will be noted, is due to the fact that the 20,000 lb. per sq.in. working stress used for the silicon steel is 5000 lb. per sq.in. greater than that used for the carbon steel, while the modulus of elasticity for both materials is the same. Beam connections on the silicon columns were detailed as if the beams were level, a necessary expedient if the connection was to be rigid enough for wind load after the silicon steel columns had shortened under load.

Wind design

Wind design calculations for the RCA Building in Rockefeller Center were made by the cantilever method, which assumes that wind stresses in columns are proportional to the distances of the columns from the axis of the building. This method was used for the north-south or principal wind bents, and beams were chosen increasing in stiffness toward the center so that the amount of joint rotation due to the beam deflection under calculated wind shears would be as nearly as possible the same for beams on each side of the columns. For the long east-west bents the beam sizes were not increased as much toward the center of the bents as would have been the case if the theory had been applied to these bents without modification.

Graduated wind pressures

Assumed wind pressure values were graduated downward from a maximum at the top. On the Manhattan Company Building and the Empire State Building in New York, high pressures (30 to 40 lb.) were used for the top few stories, and then reduced abruptly to 20 lb. for the balance of the building. But in the RCA Building a 30-lb. pressure was used at the top, decreasing by about 2½-lb. increments for each 100 ft. until 20 lb. was reached at about the 400-ft. level or mid-height. A pressure of 20 lb. was then used for the portion of the building between the 100- and 400-ft. levels. Below the 100-ft. level no wind pressure was assumed.

The various steps in the wind-design calculations may be summarized as follows:

(1)—Figure overturning moments from wind pressure loads.

(2)—Compute vertical wind loads in columns, using already calculated dead and live loads as measures of column areas and assuming unit stresses to be proportional to distances of columns from the center of the bent.

(3)—Compute the wind shears in the beams from the vertical wind loads in the columns. The wind shear in an outside beam will be the difference between the wind load in the outside column in the story below and the story above. For the next beam the shear will be equal to the summation of the shear in the outer beam and the difference between the wind loads in the story below and the story above for the next column, and so on to the center of the bent.

(4)—Figure the movement of the top of the building due to deformation of columns under vertical wind loads. The total movement of the top was limited to 0.00166 of the height (a ratio of 1:600), assuming all wind pressure resisted by the steel framing. The difference between the total allowed movement of the top and that computed as due to change in length of columns gave the amount of deflection allowable from beam and column bending. This amount was assumed as distributed to the various stories in proportion to the story heights.

(5)—Taking an outside column and using the wind shears determined in (3), calculate the moment of inertia of the beam required to give the allowable story deflection due to bending.

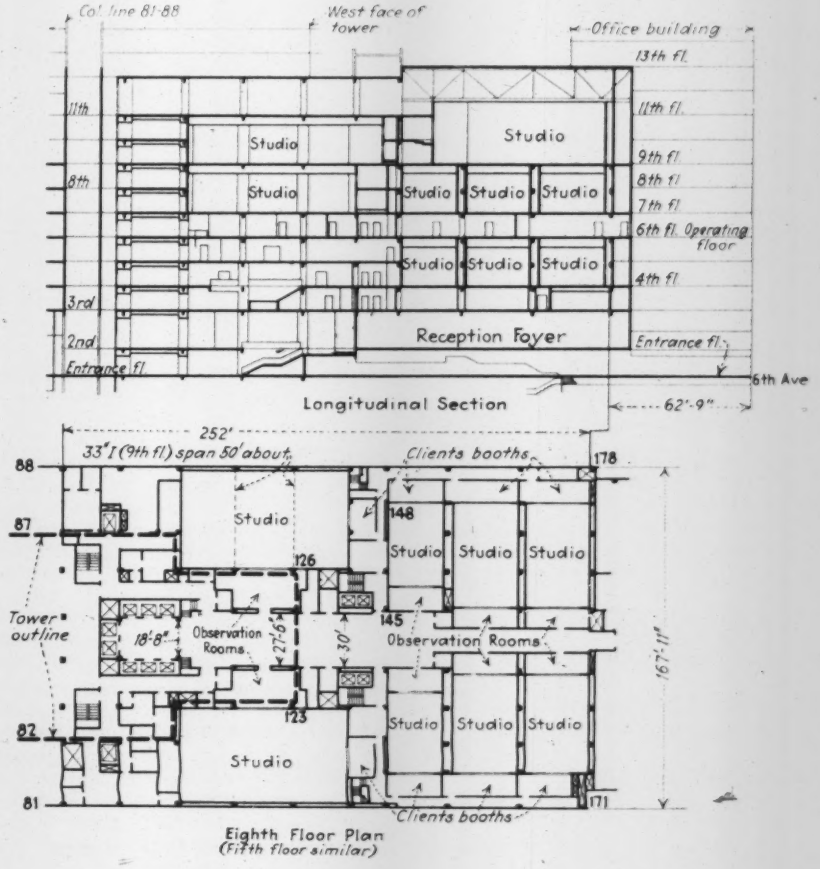
(6)—Choose the sizes of the remainder of the beams in the bents, obtaining a moment of inertia in each case from the moment of inertia of the outside beam, as determined in (5), using a ratio of wind shear in any individual beam times the square of one-half the span of this beam divided by the product of the wind shear in the outside beam and the square of one-half the span of outside beam.

(7)—Compute the wind shears in the beams, assuming that the wind shear taken by the columns will be determined by the stiffness factors (I/l) of the column and the beams framing into it and assuming that the floor slab will act as a horizontal girder to force all columns to deflect equally.

(8)—Check this distribution of shears with that obtained in (3) and change the beam sizes if necessary to bring the two into substantial agreement.

(9)—Compute all moments, deter-

Fig. 4—Broadcasting studios two and three stories high occupy central section of RCA Building.



mine connection types and check all sizes for combined stresses.

Wind connections

For wind resistance, columns are placed with their stiffer axes north and south. An exception to this occurs in the lower stories where three-web columns are placed in the elevator shaft walls. These columns are adequately stiff in either direction and thus are set with their webs east and west to provide better elevator clearance. In the upper stories, where these elevator shaft columns become smaller and less stiff, they are turned so that their webs are north and south.

In the office and lobby areas of the building the wind connections are in general split I-beams. In locations where deeper connections are required than can be provided by the I-beam stubs, they are supplemented by a section of an H-beam upon which the wind girder is carried. In the elevator shaft walls, full-story, double-angle knee-braces are used in both directions. The largest angles used are 7x3½x1 in. and none is smaller than 6x4x⅜ in.

The broadcasting studios

Section No. 9, the west section of the RCA Building, is notable for the elaborate layout of broadcasting studios that it contains. A section through the studio section and a plan of one of the floors is shown in Fig. 4. The studios have been placed outside the tower portion of the building because the long-span framing required could not economically be worked into the heavy tower steelwork. Studios are on three floors, the fourth, seventh and ninth, with some special studios occupying part of the tenth floor. Most of these studios are two stories in height, although the largest, on the ninth floor, has a ceiling height of nearly three stories. All control apparatus is on the sixth floor.

The steel framing in this unit is somewhat unusual but not especially complicated. Two trusses of 68-ft. span, placed between the third and fourth floors, carry two columns each over an entrance foyer leading from the Sixth Ave. office building into the studio unit.

The ceilings of the studios themselves are in general framed with 33- or 36-in. rolled girder beams, some with spans up to 50 ft. Over the large studio on the ninth floor six trusses 16 ft. deep and 107 ft. long, with their top chords at the 13th-floor level, form the roof of the studio unit. They are designed to carry four or five more floors of steel, if it should ever be desired to increase the height of the studio unit. These trusses and the framing in other parts of the roof are also made adequate to support the shrubbery, trees and fountains proposed under the landscaping plan. Some of these special loads are as high as 400 lb. per sq.ft.

In an article in the *Architectural Forum* for August, 1932, O. B. Hanson, chief engineer, National Broadcasting Co., describes the plan of the broadcasting studios. It has been estimated that 27 studios, six audition rooms and other appurtenant rooms will be required; and to house these studios and offices about 500,000 sq.ft. of floor space will be needed, of which 370,000 will be required for the studios.

The main lobby and the main studio elevators occupy that part of the building directly beneath the mass of the tower. The main control room has been centrally located on the sixth floor and ready access from it can be had to the three studio floors by means of private elevators. On each of the typical studio floors elevators open into private corridors that communicate directly with the individual control and monitoring booths of each studio. The layout is such that at no time is it necessary for any of the production staff to enter upon the communicating corridors and the lobbies provided for the performers.

In addition to the needs of musicians and performers it is planned to accommodate adequately the clients and guests of the broadcasting company. On floors 2, 5, 6, 8 and 10, public reception rooms and observation galleries are provided. In the larger studios the observation galleries are to be equipped with theater seats. In all but a few instances observation galleries are separated from the studios by sound-insulated, transparent partitions. Private observation rooms are provided for the sponsors of programs, and on the sixth floor an observation room, separated from the main control room by plate-glass windows, will permit the operating equipment to be seen.

In addition to the large studios on the fourth, seventh and ninth floors, there are a number of small studios on the ninth floor designed especially to handle speakers and small productions. The large studio on the ninth floor has floor dimensions of 80x130 ft. with an average ceiling height of 33 ft. and will be equipped with a balcony on the tenth floor with seats for about 500. Another studio on this floor, 50x65 ft., the second largest of the group, is planned for dramatic productions which require a stage and a local audience. If and when television reaches a point where its operation is comparable to the making of motion pictures, these two studios will be useful because of their large floor areas. On the tenth floor there are planned four studios grouped around a central control room so that simple television broadcasting of drama productions may be done. The various scenes can be set up in these studios and the television camera or scanner in the control room can be rotated and focused on the four studios in proper sequence.

Sound insulation is of great importance. As in previous broadcasting studios, the walls, floor and ceiling of each studio will be supported free of the building structure by means of clips, chairs and hangers. Walls and ceilings contain rock wool held in place by perforated steel plates in addition to lath and plaster. Floors are wood on a concrete and rock lath base. Hair felt is used in the joints between walls and floors, also around doors and windows.

In addition to sound insulation, air conditioning is necessary. It is believed that the air-conditioning plant for the studios will be the largest and most complete in the world.

Materials and Structural Elements in the Buildings of Rockefeller Center

SEVERAL significant facts stand out in any consideration of the materials and structural elements that were chosen for use in Rockefeller Center. First is the vast quantity of materials required, the total weight of which for the completed development is estimated to be about 917,000 tons. Second is the fact that none of the structural materials, as distinguished from the purely architectural or decorative materials, can be characterized as a new material. All have been used before. In fact, prior use and demonstrated serviceability bulked large among the reasons for their adoption. The structural elements, too—walls, floors, roofs, partitions, windows, doors — are of standard construction, with detailed exceptions in the walls and in those roofs that are to be landscaped. In the case of decorative materials some disregard for precedent occurred, although it was not extensive. Finally, in the broadcasting studios the acoustical materials and sound-proof construction present elements of interest.

Huge quantity of materials

The accompanying tabulation of quantities and weights of materials in the units so far built, with the estimate for the entire project, emphasizes the large scale upon which Rockefeller Center is planned. The reasons for the adoption of these particular materials do not vary

MATERIALS AND EQUIPMENT IN ROCKEFELLER CENTER
From a Recent Tabulation

Items	RCA Building* Sections 1 and 9		RKO Bldg. &† International Music Hall No. 10		RKO Photoplay‡ Theater, No. 8		Entire Development	
	Quantity	Wgt., Tons	Quantity	Wgt., Tons	Quantity	Wgt., Tons	Quantity	Wgt., Tons
Air cooling & cond. equip.			425		264		689	
Aluminum spandrels & sills	6,000	402	1,714	118.8	(60 sills)	0.7	15,000	844
Asbes. pipe covering, lin.ft.	121,970	45	52,300	20	13,390	5	367,660	137
Brick — Common	10,380,000	18,683	5,225,000	9,405	1,770,000	3,187	34,750,000	62,550
Pressed	830,000	1,660	671,000	1,340	550,000	1,100	4,000,000	8,000
Glazed			350,000	700			350,000	700
Brass pipe, lin.ft.	93,930	245	34,734	75	16,350	31	290,000	702
Bronze store fronts, lin.ft.	3,434	100	176	4			6,610	190
Bronze door saddles	4,500	22	600	3	150	1	10,000	50
Copper wire & cable, lin.ft.	3,400,000	409.5	2,166,000	230.3	600,000	35	12,250,000	1,338
Cement, portland, bbl.	167,100	31,247	46,200	8,640	22,500	4,207	471,000	88,077
Cinders, hard coal, cu.yd.	87,000	56,550	23,800	15,470	5,200	3,380	232,000	151,800
Cork, insulating, sq.ft.	86,000	10	60,000	7	32,000	4	353,000	43
Elevators, incl. cabs & equip.	74	1,413	23	960	3	84	185	3,704
Escalators	6	128					6	128
Fire hose, lin.ft.	17,500	6	6,350	2.0	2,300	0.7	51,150	16.5
Fire-hose connections	372	11	147	4.5	46	1.5	1,065	32
Glass, plate & sheet, sq.ft.	351,400	296	70,100	54	8,100	8	830,000	690
Granite, cu.ft.	3,400	280	4,250	350	4,000	330	23,700	1,950
Iron & steel								
Doors	9,000	963	1,200	128	300	32	20,000	2,140
Elevator inclosures	1,280	669	308	161	21	11	2,969	1,551
Electric conduit, lin.ft.	1,540,000	193	484	60	112,000	14	4,136,000	517
Electric outlets	45,600	11.4	15,700	3.9	2,700	0.7	124,000	31
Light iron, miscellaneous		196		77		75		648
Picture molding, lin.ft.	605,000	151	95,000	24	700,000	175	1,200,000	300
Pipe	340,000	455	129,400	194	59,800	65	1,057,500	1,420
Reinforcing mesh, sq.yd.	311,000	1,865	86,667	520	19,550	115	834,000	5,000
Reinforcing rods, lin.ft.	41,440	259	16,720	209	5,200	32	126,700	1,000
Stairways	73	340	76	225	14	45	326	1,220
Structural steel		58,500		13,363		3,220		125,000
Tanks		403		217		81		1,340
Vent. ducts, sheet iron		429		125		80		1,259
Windows	5,804	580	1,608	251	71	7	14,000	1,568
Lighting fixtures	24,000	60	8,329	23	1,000	5	66,000	158
Lime for plaster		1,250		400		45		3,390
Limestone, cu.ft.	190,000	14,250	70,400	5,280	22,500	1,690	563,000	42,228
Lead, pipe	3,700	11	500	2	200	1	9,000	29
Marble, structural, cu.ft.	9,200	736	1,700	136	600	48	23,000	1,840
Paint, incl. str. steel, gal.	81,100	405	27,400	137	8,000	40	215,000	1,085
Pipe organs, incl. consoles			2	33.9	1	16.3	3	50.2
Plaster, neat		4,700		10,000		180		30,000
Plaster, acoustical				1,100		65		1,165
Plaster of paris		1,000		1,000		20		4,000
Plumbing fixtures	2,075	185	859	64	277	23	6,611	529
Radiators, iron	5,700	168	1,170	95	184	44	14,054	607
Radiation, sq.ft. copper	198,000	28.9	65,000	6.9	19,550	0.7	550,000	69.5
Sand, cu.yd.	63,400	82,420	17,200	22,360	14,000	18,200	189,000	245,700
Stone, crushed, cu.yd.	8,600	10,750	4,530	5,650	4,000	5,000	34,000	42,400
Terrazzo floor, sq.ft.	197,000	197	17,400	17	1,950	2	432,700	432
Telephones	19,000	95	3,400	17.5	100	0.5	42,500	213
Terra cotta block, sq.ft.	2,812,000	22,496	750,000	6,000	155,000	1,240	7,250,000	58,000
Theater seats			6,000	102.5	3,500	87.5	9,500	190
Tile roofing	94,000	470	65,625	328	28,312	142	237,935	1,690
Valves & fittings		80		29		21		260
Valves	6,620		1,368		460		16,903	
Fittings	58,980		22,908		6,600		176,977	
Wood door saddles	4,500	7	600	1	150	0.25	10,500	16
Unclassified materials		6,510.2		2,110.7				19,413.8
Total weights		322,450		107,800		44,330		917,100
MATERIALS USED FOR EXCAVATING AND TEMPORARY CONSTRUCTION								
Drill steel, lin.ft.	12,000	18	12,800	19	6,000	9	55,800	78.5
Dynamite & powder, lb.	89,400	44.7	38,600	19.3	24,000	12.5	304,000	153
Hose, air & water	9,450	2.3	2,295	0.7	2,000	0.5	26,000	6.5
Lumber used in and about bldgs.	2,365,000	4,128	632,000	1,106	330,000	578	6,645,000	11,644
Total weights		4,193		1,145		600		11,882
EXCAVATED MATERIAL								
All excavated material, cu.yd.	167,600	293,300	80,500	140,875	32,200	56,300	624,000	1,248,000

* RCA Building: Volume, cu.ft. 37,000,000; Rentable area, sq.ft. 2,100,000

† RKO Building: Volume, cu.ft. 5,640,000; Rentable area, sq.ft. 362,200

International Music Hall: Volume, cu.ft. 7,853,000; No. of seats 6,000

‡ Sound Theater: Volume, cu.ft. 4,484,000; No. of seats 3,500

substantially from the reasons that have obtained on other modern buildings. Both merit and price always played a part. Appearance was often controlling. Availability in sufficient quantity had always to be considered. Time required for delivery and erection influenced the choice. Building code requirements in several cases made the use of certain materials mandatory. And finally, in one or two instances the desired arrangement or size of some structural element dictated the adoption of one material over another one. A few notes on some of the more important materials will illuminate this phase of the work more completely.

Selecting the materials

Steel for the framework of the buildings, some of which were high and others of which were complicated, was chosen as a structural necessity. Precedent dictated its use, and speed of erection was a factor.

The use of cinder concrete for the floor arches was almost entirely a matter of precedent. Except in rare instances, it is used almost exclusively in New York buildings and has the advantages of low price and light weight.

Brass pipe was chosen for the hot- and cold-water piping because of the freedom it offers from corrosion troubles and water discoloration. Plumbing connections were of lead pipe as required by the building code. Galvanized steel pipe was employed for the soil stacks. Wrought-iron pipe was used in connection with the dehumidifiers and air-cooling towers of the air-conditioning systems in the two theaters. The corrosive action of aerated water, due to the presence of a certain amount of sulphur in the outside air, which creates an acid condition in the water, is effectively overcome by the use of wrought-iron pipe in these locations.

Copper radiators were chosen because of the small space they occupy and because they are light in weight in relation to the radiating surface that they provide.

Silencers or ventilating units were installed beneath the windows, in line with the most modern thought in office-building planning. Baffles in the units remove dust particles from the air and reduce its velocity, at the same time shutting out street noises. Because of these ventilating units, it is claimed, the windows need not be opened.

Thin spandrels required

The choice of aluminum spandrels hinged on thickness, weight, price and permissible architectural treatment. A thin spandrel was required so that the radiators and the ventilating units could be recessed into the walls beneath the windows. Either aluminum or lead or some other metal would have served, but aluminum was lighter and could be made to harmonize more readily with the limestone wall facing than could other materials.

The limestone facing was adopted because of its availability, price and color. A French sandstone was seriously considered but was found to be expensive and difficult to secure in large quantities. On the ground of appearance alone a domestic sandstone would have been satisfactory, but its laminations were believed to be detrimental to its weather resistance.

Brick was adopted for wall backing instead of cinder block or hollow tile because it is required by the building code to lend rigidity to a thin stone facing such as is used on the Rockefeller Center buildings.

Granite is used for the water table at the bottom of the buildings, in line with past practice.

Around the elevator shafts, stair inclosures and toilets, terra cotta block partitions are used. Terra cotta is lighter and is said to be cheaper than

brick, and no code requirements restricted its use in interior partitions as they did in the walls. An exception to the terra cotta block occurs in the broadcasting-studio portion of the building, where special porous concrete blocks were desired by the broadcasting company.

For the minor roofs—that is, those not used for observation galleries and gardens—tile roofing of ordinary type was specified. A section showing the special waterproofing provisions on the roofs that are to be landscaped is shown in Fig. 5 in the article on the theaters on p. 586. It will be noted that in the troughs in which the planting will be done a 2-in. cement protection is applied over the 1-in. waterproofing membrane, in turn resting on a 2-in. layer of cork that is used for heat insulation on all roofs. The finishing materials to be used on the garden walks have not yet been definitely chosen.

Wall design

Walls were the subject of considerable study and, as designed, they differ somewhat from usual practice. Facing is limestone with aluminum for spandrels. Backing is common brick. The thinness of the aluminum spandrel reduces the total thickness of the wall at the windows sufficiently to permit installation of a radiator and a silencer-ventilator unit within the usual wall depth (Fig. 1). In the floors, steel I-beams 7-ft. on centers carry 4-in. cinder-concrete arches. On top of the concrete arches is placed a 3-in. fill and a 1-in. finish, the latter with colored integral hardener. A terrazzo finish is used in the corridors whose locations are definitely known. In tenant spaces that are not yet rented the corridor space is left unfinished. When the tenant's desired floor layout is available, the necessary corridors are given a terrazzo finish, while the remainder of the theoretical corridor space is finished as usable floor area in accordance with the tenant's wishes.

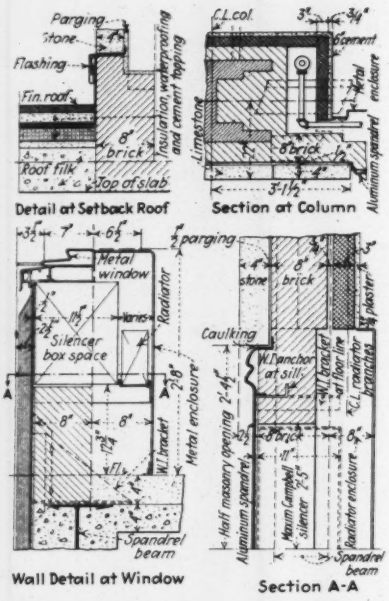


Fig. 1 — Typical details of walls in Rockefeller Center buildings. Note use of aluminum spandrels and silencer boxes and small, shallow radiators inclosed in a metal housing.

Partitions dividing tenant space into offices (movable partitions) will be of the usual type—that is, 3-in. gypsum, covered both sides with lime plaster.

The roofs, as previously stated, are concrete slabs covered in sequence with fill, cork, mortar, five-ply waterproofing and tile. Parapets are of stone with special aluminum spandrels above the windows. Stone and spandrels are anchored to brick back-up resting on the concrete roof slab. Parapets of roofs that will be used for observation purposes are faced on the inside as well as on the outside with stone.

Flashing of the base-and-cap type is used on all roofs. Where stone facing is used inside the flashing is carried up behind the stone.

Except for inclosed roof areas where swinging windows will be utilized, all other windows in the development are of the double-hung type, filling masonry openings 4 ft. 9 in. wide by 6 ft. 8 in. high.

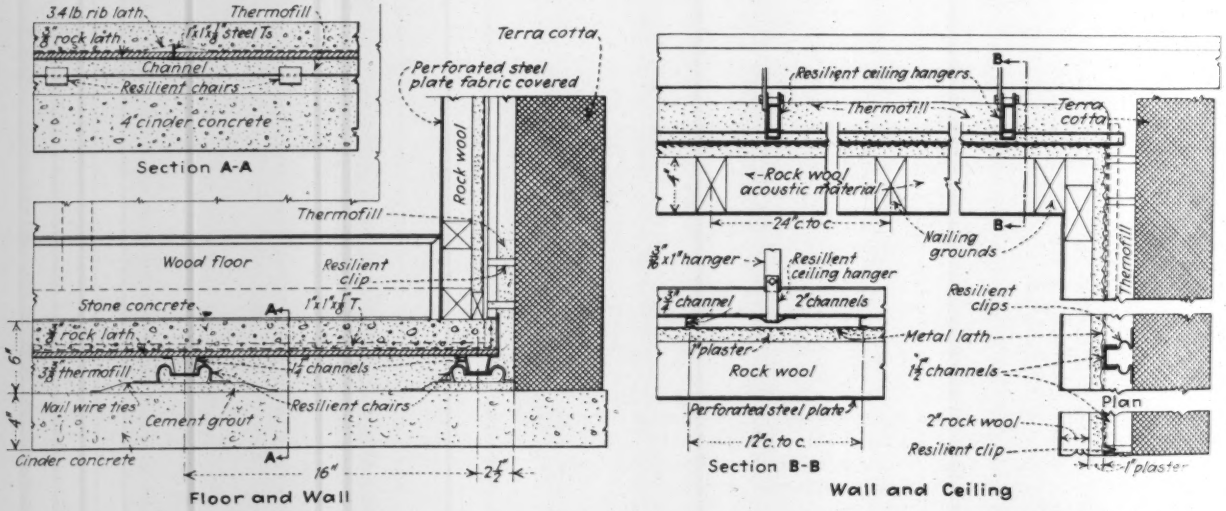
"Floating" construction

Special construction is used in the studio units, where sound insulation is of great importance. As shown in Fig. 2, the walls, floors and ceilings in each studio are floated free from the building structure by the use of resilient chairs, clips and hangers. A layer of thermofill and rock lath is used below the floors and the walls and ceilings are treated with thermofill, metal lath, plaster, rock wool and an outer surface consisting of a fabric-covered perforated steel plate. These steel plates may be moved mechanically so as to create various acoustical conditions best suited to each type of broadcasting program.

Effective insulation

Such elaborate insulation is particularly necessary in steel-frame buildings. In Europe it is said that the use of steel framework in broadcasting studios is barred because of the difficulty of sound control where steel is involved. However, practice in American studios has shown that with complete isolation of each studio from the steel frame, a sound attenuation of about 60 decibels may be obtained. As between two studios similarly soundproofed, an attenuation of more than 100 decibels is therefore possible. In addition to walls, floors and ceilings, doors and windows are thoroughly sound-proofed, and observation galleries around studios are isolated by two thicknesses of plate glass separated by an air space.

Fig. 2—In the studio unit all broadcasting and control rooms are of so-called floating construction, being carried free of the structural-steel framework by means of resilient chairs, clips and hangers and insulated against sound by means of thermofill, rock lath, plaster, rock wool and fabric-covered steel plates.



Skyscraper Plumbing in the RCA Building

Water supply and sewerage design for the modern tall building includes certainty of operation and flexibility as basic requirements—High pressures require division of building into zones for water service—Storm and sanitary sewer systems separate—Ejectors and sump pumps on basement sewer systems

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THE ADAPTATION of plumbing to the tall building represents one of the most complete changes of any of the mechanical arts used in building construction. So complete has been the change that the very name of "plumbing," which is a derivative from the Latin *plumbum* (meaning lead), is really a misnomer since lead is no longer used for water supply pipes and very little of it is used in other parts of the system. In Rockefeller Center the RCA Building of 69 stories presents a notable example of skyscraper plumbing. In general it is typical of modern practice in this relatively new field, and the discussion in this article is planned as much to emphasize the general requirements of tall building water supply and sewerage as it is to describe the particular systems that are being installed in the RCA Building.

A skyscraper plumbing system is made up of a number of component parts. Basically it is divided into sewerage and water supply. Storm drainage from roofs, and such interior drainage as overflows from tanks and sanitary drainage or pumpage from toilets, constitute the sewerage requirements. Hot and cold water must be provided for house use. Water must always be available under pressure for fire protection service. And in the RCA Building an elaborate air conditioning plant in the studio unit requires large volumes of condensing water, while the roof garden fountains will exert their own special demands upon the water supply. These various services must be furnished by a system of piping and equipment whose continuous and efficient functioning is absolutely certain and whose arrangement is flexible and complete enough to meet the demands of any tenant, however exacting his requirements.

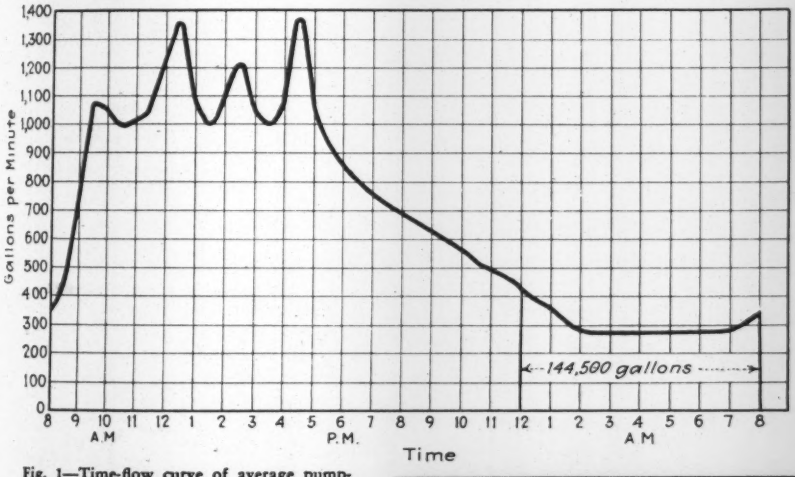


Fig. 1—Time-flow curve of average pumping load, illustrating the type of demand made on the city water system by the Rockefeller Center project. Night load represents largely water required for cleaning purposes. Condenser water for the air-conditioning equipment is not included.

The engineer who designs plumbing systems for tall buildings must begin his work at the conception of the building. He must cooperate with the architect to determine the water, sanitation, storm drainage, cleaning and fire protection needs of the structure. In addition, the requirements for public toilet fixtures, intermediate and elevated tanks, intermediate fire pumps, main pipe shafts, stacks for future fixtures, machine rooms, and other equipment for the building are factors which materially affect the design of the building frame, and he must be cognizant of the structural engineer's problems.

The basic determination which must be made by the sanitary engineer and which affects practically every computation of sewerage is an approximation of the future maximum population of the building. By empirical data and comparisons with similar-type buildings, in similar locations, this future population is determined in terms of square feet per person, the net rentable area of the building being known. This figure varies from about 85 to 200 square feet per person, in various buildings. In addition, more specific determinations show variations for different sections of the same building. After the total population has been determined it is divided according to the ratio of the sexes in the building, as a criterion of toilet facility requirements.

Before discussing any particular feature of a plumbing system for a tall building, it is advisable to call attention to a basic factor that is applicable to every type of sanitary installation, but which is of major importance in skyscraper systems. This factor has been determined mathematically and pub-

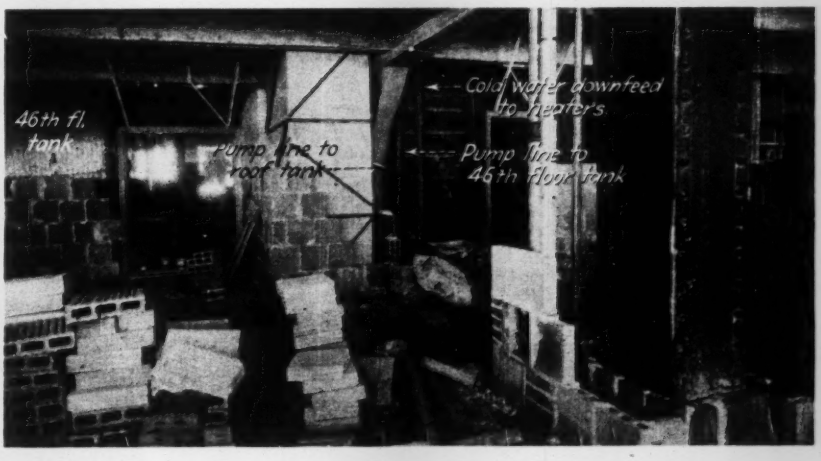


Fig. 2—Plumbing facilities at the 46th floor. At left, 22,000-gal. tank, showing galvanized steel pipe discharge from fire reserve at bottom. In center, brass pipes which are labeled are in main pipe shaft, which also carries the galvanized steel vent pipe from the ejector system in the basement and the main storm water leader as well as the steam pipes. In right foreground is a typical private tenant riser layout at an interior column, showing method of furring.

lished in the building code of the U. S. Department of Commerce, being generally defined as the "probability factor." It is the ratio of the total number of fixtures in a building to the number of fixtures that may be simultaneously operated. It can easily be seen that should pipe sizing be based on the total number of fixtures installed rather than the fixtures that will be simultaneously operated, the sizes which would be required would be far in excess of their use. For purposes of pipe sizing the probability factor is applied individually to each stack, assuming the fixtures that will be simultaneously operated at the top as 100 per cent and decreasing proportionately as fixtures are added. The factor is then applied to the main collecting drains, decreasing in value as each stack with its fixtures is connected in, so that the minimum value (usually less than 15 per cent) is reached just before the drain joins the street sewer.

With regard to water supply, estimation of daily or hourly consumption in a building has no bearing on the design, although it is useful in determining the cost of water and may be of assistance to city departments in computing necessary reservoir capacity. The general flow curve for Rockefeller Center (Fig. 1) illustrates the type of demand that a skyscraper or group of buildings can impose upon the mains installed in the streets for water distribution. These mains as well as the piping inside of the building must be sized for maximum instantaneous demands. Empirical data similar to that illustrated by this curve may, with proper consideration, be of value in the determination of the effect on the public water supply mains of a skyscraper that may be built in any section of a city. Although the curve illustrated applies particularly to one installation, the general characteristics coincide with the water consumption curves of many other buildings. These curves are a physiological measure of the habits of the occupants, the first peak indicating delayed morning ablutions; the second, the pre-luncheon lavatories; the third, the after-luncheon lavatories; and the fourth, the general cleansing before leaving for home. The night load indicates the requirements of the scrub women.

Per capita water consumption

The factor that has most direct bearing on skyscraper plumbing design is per capita consumption. The value of this will vary with the type of building, the type of plumbing system to be installed and the maintenance efficiency of the staff that will operate the system. It has been found that the value can be decreased by incorporating in the design:

(1) A hot water system of the recirculating type so that hot water is available at the fixtures with extremely short and small connections between the circulating loop and the fixture, thus eliminating the necessity for draining the "dead water" from the pipe before hot water is delivered from the faucet. This feature not only effects a saving, but is contributory to the comfort and efficiency of those using the water.

(2) A circulating drinking-water system or provision for coolers with the same general requirements as described above for hot water.

(3) Lavatory faucets of the spring-actuated self-closing type which must be held open to obtain water. The saving effected by the use of this particular type of faucet is enough to justify an ordi-

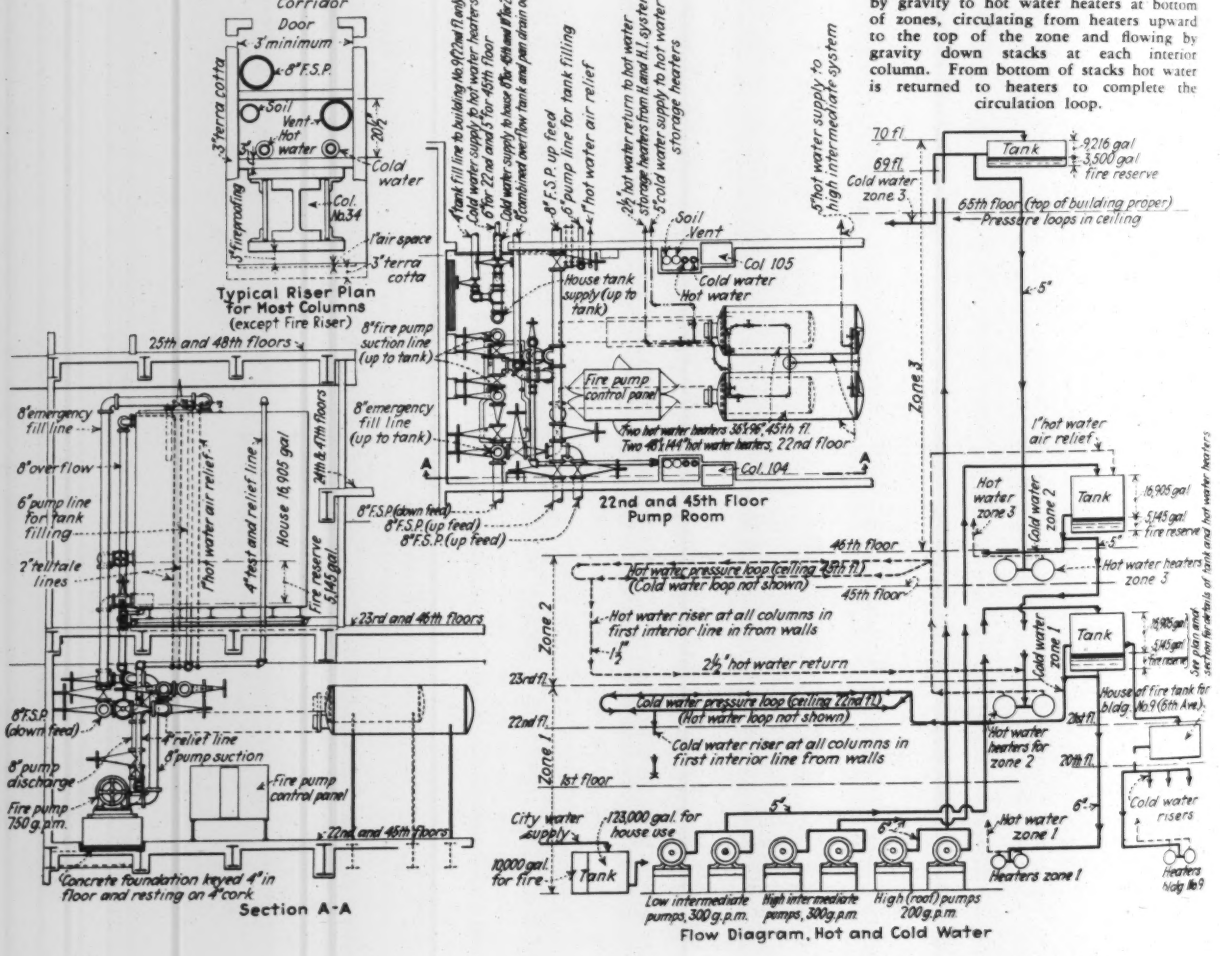

Typical Riser Plan for Most Columns (except Fire Riser)
Section A-A
22nd and 45th Floor Pump Room
Flow Diagram, Hot and Cold Water
Tank
Fire pump control panel
Hot water heaters zone 1
Cold water risers
Heaters zone 1
Hot water zone 1
Hot water heaters zone 2
Hot water heaters zone 3
Hot water zone 3
Cold water zone 3
Cold water zone 2
Cold water zone 1
Zone 1
Zone 2
Zone 3
City water supply
123,000 gal. for house use
10,000 gal. for fire
Low intermediate pumps, 300 g.p.m.
High intermediate pumps, 300 g.p.m.
High (roof) pumps 200 g.p.m.
Hot water pressure loop (ceiling 45th fl.)
Cold water pressure loop (ceiling 22nd fl.)
Hot water riser at all columns in first interior line from walls
Cold water riser at all columns in first interior line from walls
2½" hot water return
1" hot water air relief
Pressure loops in ceiling
65th floor (top of building proper)
46th floor
45th floor
23rd floor
22nd fl.
1st floor
20th fl.
2nd fl.
70 fl.
69 fl.
9216 gal
3,500 gal fire reserve
15,905 gal
5,145 gal fire reserve
House tank supply (up to tank)
Soil
Vent
Col 105
Col 104
Cold water
Hot water
Concrete foundation keyed 4" in floor and resting on 4" cork

Fig. 3—Hot and cold water systems are of the down-feed type. Pumps in the basement fill tanks at 23d and 46th floors and roof. Cold water flows by gravity to zones below each tank. Cold water also flows by gravity to hot water heaters at bottom of zones, circulating from heaters upward to the top of the zone and flowing by gravity down stacks at each interior column. From bottom of stacks hot water is returned to heaters to complete the circulation loop.

nance in any locality where water supplies are limited.

(4) Water closets of a type that can be operated with a minimum water consumption, in conjunction with flush valves that can be regulated to provide the minimum flush as required by the bowl.

If the above items have been properly considered and provided for, it is possible to decrease the per capita consumption to 50 per cent of that in a building that is operated with a system that has not been properly designed. The minimum water consumption, for plumbing purposes only (and not including air, conditioning requirements, which usually are in excess of sanitary requirements), of which the writer has any record, is 14.7 gallons per person per day, which figure is taken over a yearly average. A close approximation to this value will be obtained for the RCA Building inasmuch as all the features described above have been incorporated in its plumbing system, and in addition the efficiency of the maintenance staff is certain to be high. Variations have been found from this low figure to in excess of 30 gallons per capita, taken on the same annual basis.

Although practically every community, regardless of size, requires plans of the sewerage systems in a building to be filed with city departments for examination, none requires the plans of the water distribution system. The above consumption figures would indicate that proper examination by qualified engineers of water plans might possibly effect savings in municipal water supplies, increase the comfort of the occupants of a building and decrease the owner's water bill.

Hot and cold water

The water system for the 69-story RCA Building is divided into three zones of about 23 floors each. The number of zones into which a building should be divided is determined almost wholly from economic considerations. Increasing the number of zones reduces the sizes of tanks, pumps and piping, but it also increases the number of tanks and pumps and the amount of pipe as well as introduces additional architectural and structural charges for hung ceilings and machine room framing. A general study of alternative cost requirements in the RCA Building resulted in the adoption of the three-zone system.

Regardless of the economics involved, however, some zoning of the water system in a tall building is absolutely necessary because of the high pressures that obtain. The limiting pressure at a fixture varies with the judgment of the individual designer, usually being not over 60 to 70 lb. In the RCA Building a value of 60 lb. was chosen; pressures in excess of this are limited by pressure-reducing valves.

A description of the water system in any one zone will give a picture of the system for the entire building, since the general design of the piping and equipment in each zone is the same. A flow diagram and details of the tanks, heaters and piping are shown in Fig. 3.

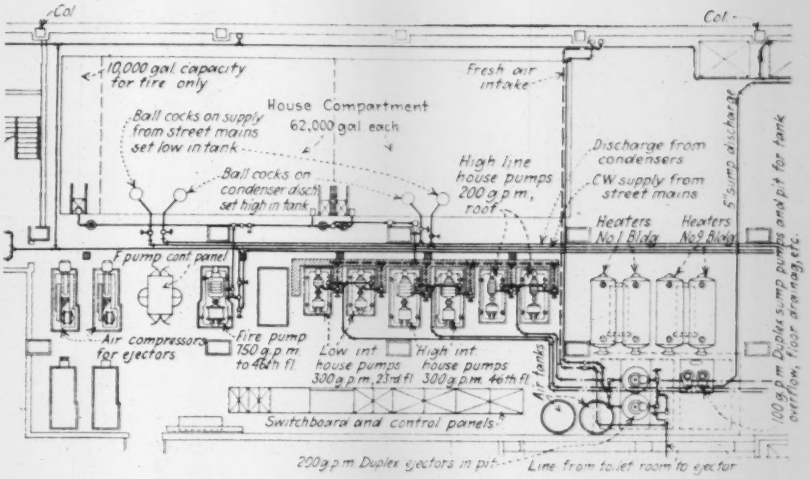

Col
Col
10,000 gal capacity for fire only
Fresh air intake
House Compartment
62,000 gal each
Ball cocks on supply from street mains set low in tank
Ball cocks on condenser disch. set high in tank
High line house pumps 200 g.p.m., roof
Discharge from condensers
C.W. supply from street mains
5" sump discharge
Heaters No. 1 Bldg.
Heaters No. 2 Bldg.
F pump cont. panel
Air compressors for ejectors
Fire pump 750 g.p.m. to 468 ft.
Low int. house pumps 300 g.p.m. 234 ft.
High int. house pumps 300 g.p.m. 468 ft.
Air tanks
Switchboard and control panels
100 g.p.m. Duplex sump pumps and p.i. for tank overflow, floor drainage, etc.
200 g.p.m. Duplex ejectors in pit
Line from toilet room to ejector

Fig. 4—Main machine room in basement, showing the three pairs of house pumps that serve the tanks at the top of each of the zones of the building; ejectors, with compressors and air receivers as auxiliary equipment for handling all sewage originating below the city sewer level; hot water heaters; and fire pump.

The systems for both hot and cold water are of what is generally known as the "down-feed type." Water is obtained from the city mains in the streets surrounding the project. The supply piping is so arranged that should any one street main be shut down for repairs, the operation of the building will not be impaired. After being metered the individual service lines are combined into a manifold that delivers water to a 133,000-gallon suction tank in the basement (Figs. 3 and 4). Water level in the tank is maintained by ball cocks that automatically shut off the city supply when the water level reaches a predetermined level. From the suction tank the water is drawn by three sets of duplicate electrically-driven centrifugal pumps and delivered to a house tank located at the top of each of the three zones. The pumps are under automatic control, being actuated by ball float switches located in each tank.

Cold Water Supply—From each of the tanks at the top of the zones the cold water supply for its particular zone is carried to a hung ceiling immediately below the tank and connected to a loop extending around the building from which branches are taken to each of the stacks in the building. Each individual stack is valved and the water line is carried down a column or pipe shaft, with valves at every floor. Pressure-reducing valves are used in the lower portion of the zone where pressure is in excess of 60 lb.

Hot Water Supply—The hot water system also is of the down-feed type and so arranged that the entire system constitutes a thermal loop. This is accomplished by locating the hot water heaters on the level below the lowest floor of the zone. The heaters obtain their supply from a separate cold water make-up direct from the tank at the top of the zone. They feed the hot water upward through a hot water supply line to the hung ceiling under the tank where it is connected to a hot water loop similar to that used for cold water distribution. From the distribution loop the hot water supply lines of the individual stacks are carried down and valved in a manner similar to the cold water lines but differ in that a circulating line is taken from the bottom of each and carried back to the hot water heaters to complete the circulation loop. The rate of circulation of hot water is a direct function of the height of the zones, which in the RCA Building is sufficient to cause excellent circulation without recourse to any kind of circulating pumps.

Provision for expansion of hot water lines is made by means of joints made up of six elbows and connecting nipples located at intervals, with anchors located equidistant between the expansion joints. To avoid stress on any of the piping at the branches, swing joints are provided to take up the motion.

All hot and cold water piping is covered with insulating material, the hot water being insulated to conserve heat and the cold water to prevent moisture in the air from condensing on the surface of the pipes and causing damage to the structural steel frame of the building.

Water system equipment

The most important equipment in the water system of a skyscraper is the pumping machinery. The pumps are the only pieces of dynamic machinery required and unless properly selected and connected may prove to be the weak link in the chain of water distribution. On this hypothesis, the designing engineer selects, for use on the building, the finest pumps and motors that can be made.

The tanks are of steel plate, and for

the building under discussion are of riveted construction. Welding is used successfully on many jobs, but was not utilized in this case because the tanks were included as part of the steel contract. They are heavily painted with a black asphaltum enamel which is applied hot and does not affect the water.

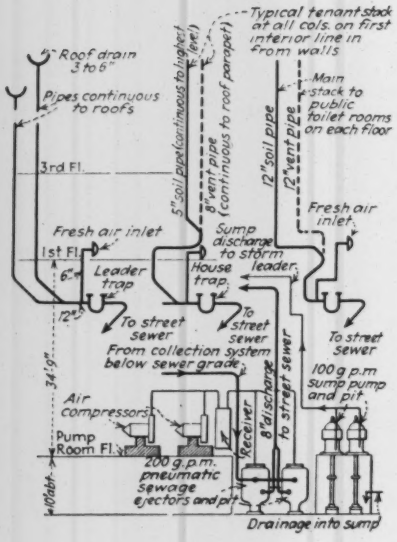
The hot water heaters are also of riveted steel plate and are of the shell-and-tube type with water in the shell and steam in the heating coils. A copper lining is provided inside the heater to prevent corrosion of the tanks and discoloration of the water. On the cold water make-up to each heater, a small shell-and-tube-type heater is also provided. This apparatus is the medium for heat transfer between the condensate from the steam radiators and the cold water make-up to the hot-water heaters. It has the dual function of economizing steam and of chilling the heating condensate before it passes to the sewer.

In general, the water that is used in the building contacts only with copper or brass from the time it leaves the city supply main until it reaches the faucets or valves from which it is discharged, except when it is in the tanks, where it contacts with an inert enamel. The pipe used will outlast the building, given only the usual minor repairs that can be expected in any mechanical installation.

Sanitary sewer system

The sanitary sewer system for discharging soil and waste matter into the sewer is completely independent of the storm sewer system, as shown in the flow diagram of Fig. 5. The general design is governed by the requirements of the New York City sanitary code, although the code, not being directly applicable to tall buildings, requires special consideration and examination. In New York City all fixtures must be separately back-vented, and the use of loop vents, wet vents and the like, which are allowed in many communities, is not permitted. In the RCA Building, as in other tall buildings, soil and vent stacks are in general continuous from top to bottom, no offsets being required to break the fall of the sewage. The main soil and vent stacks into which a public toilet is connected at each floor are 12 in. in diameter, believed to be the largest ever installed (Fig. 6). Additional soil and vent stacks from 5 to 8 in. in diameter are placed, in general, at each column in the first interior line in from the wall. These stacks, which are in the same inclosures as the hot and cold water risers (Fig. 2), are for private tenant requirements. The investment in these numerous stacks is very large considering that many of them will never be used, but they provide for the flexibility in outlets that modern business demands.

Fig. 5—Flow diagram of storm and sanitary sewer systems. Roof drains connect to leaders dropping vertically to trap below street and empty into sewer. Longest run is over 800 ft. Soil and vent stacks of sanitary system are also continuous, the longest run being about 780 ft. Sewage originating below the level of city sewers is handled by ejectors, while sump pumps remove drainage water from these same low areas.



Tests indicate that under practically all conditions the soil and vent stacks in a tall building are under a slight vacuum, which is approximately $\frac{1}{10}$ in. of water pressure or more. Should a trap seal be evaporated or siphoned in a tall building, the long open waste pipe would have more of a tendency to draw air from a room than to inject sewer gas into it. This so-called chimney effect of a stack in a tall building represents one of the major arguments for the omission of house traps from house sewer lines. It is believed by many that the omission of the trap would cause the sewers in the streets to be ventilated over the high roof tops rather than through the manhole covers in the streets where people are walking.

Basement system

The sewage discharge from fixtures on and below the ground floor of the RCA Building is carried to pneumatic-type ejectors located in the sub-basement machine room and discharged by means of compressed air to the sewer in the street. The fixtures on the ejector system are independently vented to the roof so that there is no connection between the main gravity and the basement ejector sanitary systems.

The water representing discharge from floor drains, overflow from tanks, condensate and the like is also taken by an independent system to a sump in the sub-basement from which it is pumped by duplicate automatically-controlled pumps into one of the house drains, connecting with the sewer. Flooding of the machine room is guarded against by alarms which warn of a failure of any of the sump pumps.

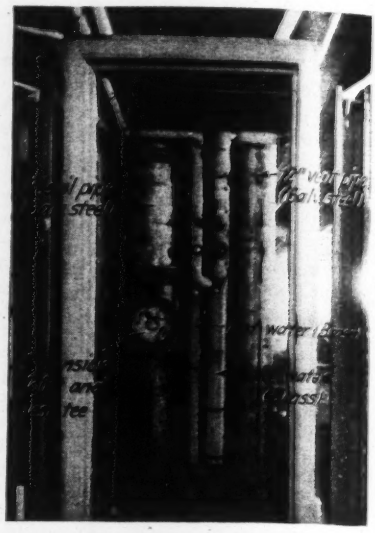


Fig. 6—Riser stack for main toilet room, believed to be the largest installation ever made. Accommodates at each floor a public toilet room of 12 water closets, 5 wash basins, 3 urinals and a slop sink. Hot and cold water risers are insulated with asbestos.

These pumps are of the heavy-duty bilge type with vertical motors set directly over the sump and with pump heads submerged so that priming is not necessary.

Storm drainage

As stated previously, the storm water system is completely independent of the sanitary system. The design of the leader boxes and pipes conducting the water from the roof drains is based on the maximum rainfall for the New York area. Where the roof of a building is some 70 stories skyward, it is economical to extend the leaders horizontally at the high roof, combining them and carrying one large pipe down the main pipe shaft. At roof setbacks leaders are also provided and combined into the main leader where horizontal runs do not affect the headroom of intermediate floors. In all other cases independent pipes are carried down the outer walls of the building. Galvanized steel piping is used throughout on the storm water system.

In order to provide interconnection between the several buildings in Rockefeller Center, it was necessary to revise all the utilities in the surrounding streets and to raise the sewers close to the surface of the streets so that the pedestrian tunnels could pass under them without interference. This brought up the problem of a practically horizontal connection between the house storm drain and the sewer with the possibility that surging might cause a discharge from the fresh air inlets located on the main house traps. To avoid this, permission was obtained from the city to raise the fresh air inlets to about the second floor of the building. Special accommodations were required in the

steel frames to provide these pipes with maximum pitch and minimum interference with other utilities in the streets.

The separation of the storm and sanitary piping in a building is not only economical in that it eliminates excessive pipe sizes, but it also makes simple connections possible if storm sewers should be provided in the streets. (The present New York system is of the combined type.) A further reason for separating the two systems in a building is that the air pressure in the soil or vent stack of the sanitary system must be limited to 1½ in. of water, which is the depth of most of the trap seals. Storm drainage water dropping nearly 850 ft., if admitted to the sanitary system piping, would necessitate the use of exceptionally large pipes to hold the pressure below this limit.

Fire protection system

Fire protection of buildings by external means such as motor-driven hose towers, ladders and similar apparatus is limited to those structures that do not exceed about six stories in height. All higher buildings must rely for a fire extinguisher on an internal water pressure system. Even for buildings of relatively low height, a modern internal fire protection system is no extravagance.

The RCA Building is equipped with a complete standby system throughout and with automatic sprinklers on the shopping basement and sub-basement floors. The system, as required in New York City and defined by fire protection engineers as the relay type, is under the jurisdiction of the city bureau of fire prevention, which carefully examines all proposed designs and cooperates with the designing engineers to the fullest extent of its experience to assure that the system is effective and practical for operation by the fire department. The name "relay" which is applied to the design results from the method of relaying the water from the street mains to the hose outlets by means of intermediate tanks and pumps.

Tall buildings require zoning of the standpipe system to limit pressures in a similar manner to that required by the general water system. In the RCA Building the zones for both house water and fire protection water are the same since it is thus possible to utilize the same tanks, fill pumps and hung ceilings for the two services. The fire service flow diagram is shown in Fig. 7. Fire pumps are located in the basement and on the 22d and 45th floors below the zone tanks in each of which, including the basement tank, a fire reserve is maintained. Each pump, with its suction connected to the adjacent tank, pumps into the fire risers of the zone above it, furnishing a pressure of 50 lb. at the highest outlet. Although ordinarily filled by the house pumps in the basement, the tanks may in an emergency be filled by the fire pumps. Thus the fire pumps in the basement can serve both the 23d and 46th floor tanks, while the 22d-floor pump can pump directly into the 46th floor and roof tanks. Pressures from the siamese connections at the sidewalk level are effective up to the roof, depending upon the fire department pumper-engine capacity.

In general, tall buildings require an intermediate fire reserve storage tank

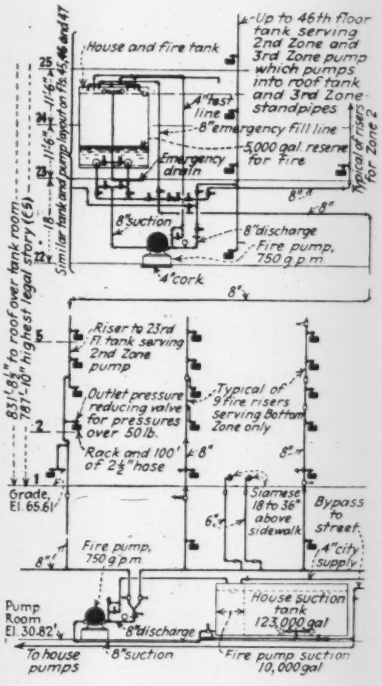

Up to 46th floor tank serving 2nd Zone and 3rd Zone pump which pumps into roof tank and 3rd Zone standpipes
House and fire tank
4" test line
8" emergency fill line
5,000 gal reserve for Fire
Emergency drain
Typical of risers for Zone 2
8" suction
8" discharge
Fire pump, 750 g.p.m.
4" cork
Similar tank and pump layout on Fls. 45, 46 and 47
831'-8½" to roof over tank room
787'-10" highest legal story (45)
Riser to 23rd Fl. tank serving 2nd Zone pump
Outlet pressure reducing valve for pressures over 50 lb.
Typical of 9 fire risers serving Bottom Zone only
Rack and 100' of 2½" hose
Grade, El. 65.61'
Siamese 18 to 36" above sidewalk
Bypass to street
4" city supply
Fire pump, 750 g.p.m.
Pump Room El. 30.82'
House suction tank 123,000 gal
8" discharge
To house pumps
8" suction
Fire pump suction 10,000 gal

Fig. 7—For fire service the building is divided into the same three zones (each about 275 ft. high) as are used for hot and cold house water service. Fire pumps are located in the basement, pump room, and on the 22d and 45th floors. Each pumps out of the adjacent house tank in which a fire reserve supply is maintained. Ordinarily filled by the house pumps in the basement, the 23d, and 46th, floor tanks and the roof tank may be filled in an emergency by the fire pumps. Pressures from the siamese connections at the sidewalk depend upon fire-engine pumper capacity.

and intermediate pump for each 250- to 300-ft. interval of height. Pipes are located throughout the building, usually in stairways, so that every square foot of area can be reached by fire hose not more than 100 ft. in length. This requirement assures that no point in a New York skyscraper is more than 100 ft. from an 8-in. standpipe on which is hanging that same amount of 2½-in. hose with a nozzle attached and water available.

Effect of air-conditioning

The effect of the air-conditioning plant (for the studio unit of the building) on the water required for sanitary purposes in the RCA Building is not material, but the effect on the total water consumption is very great. The amount of condensing water required in an air-conditioned building is dependent on the installed tonnage and the type of refrigeration machine used. The condensing water requirement is a function of such factors as outside air temperature, sunshine on the building walls, air humidity and density of population. As with the plumbing water requirement it varies with the time of day.

Inasmuch as water passed through the condensers is undamaged except for its rise in temperature, it is possible to effect a saving in the water bill by re-using the condensing water in the pumping system. Thus in designing the water system for the RCA Building, after it was decided to re-use the condensing water, average curves of plumbing and condensing water requirements were computed and then superimposed. The algebraic sum of the intercepted areas of the two time-flow curves gave an approximate measure of the storage capacity necessary if a minimum of condensing water was to be wasted. The unusually large suction tank used in the basement of the RCA Building (133,000-gal. capacity) is a direct result of the desire to conserve and re-use the condensing water.

In the RCA building the condenser discharge is carried to the basement suction tank and connected to ball cocks placed at a higher level in the tank than the ball cocks on the supplies from the street main. Before the connection to the ball cocks is made, an overflow is taken to a storm drain so that when the ball cocks are closed, indicating a full tank, the excess condensing water automatically discharges to the sewer.

When the water level in the tank recedes sufficiently, the lower ball cocks automatically open, feeding water direct from the street mains into the tank so as to maintain adequate supply for the general water system.

Roof gardens

The roof gardens planned for the low roofs of the RCA Building do not affect the general design of the water system to any great extent because separate equipment is provided. The fountains, jets and pools will be supplied with water by recirculating pumps located in hung ceilings directly under the gardens and remotely controlled. Evaporation is taken care of by means of small make-up lines under manual control taken direct from the building water system.

All planted spaces are to be provided with underground tile drains which will carry the seepage water direct to the storm drainage system. This method of drainage prevents the soil from becoming sour and interfering with plant growth. Sprays for the planting will be provided with pressure atomizing nozzles so as to simulate rainfall. Nozzles are so arranged that spray will not affect anyone on the paths or promenades of the gardens when the shrubbery is being watered.

Organization and Construction Supervision for Rockefeller Center

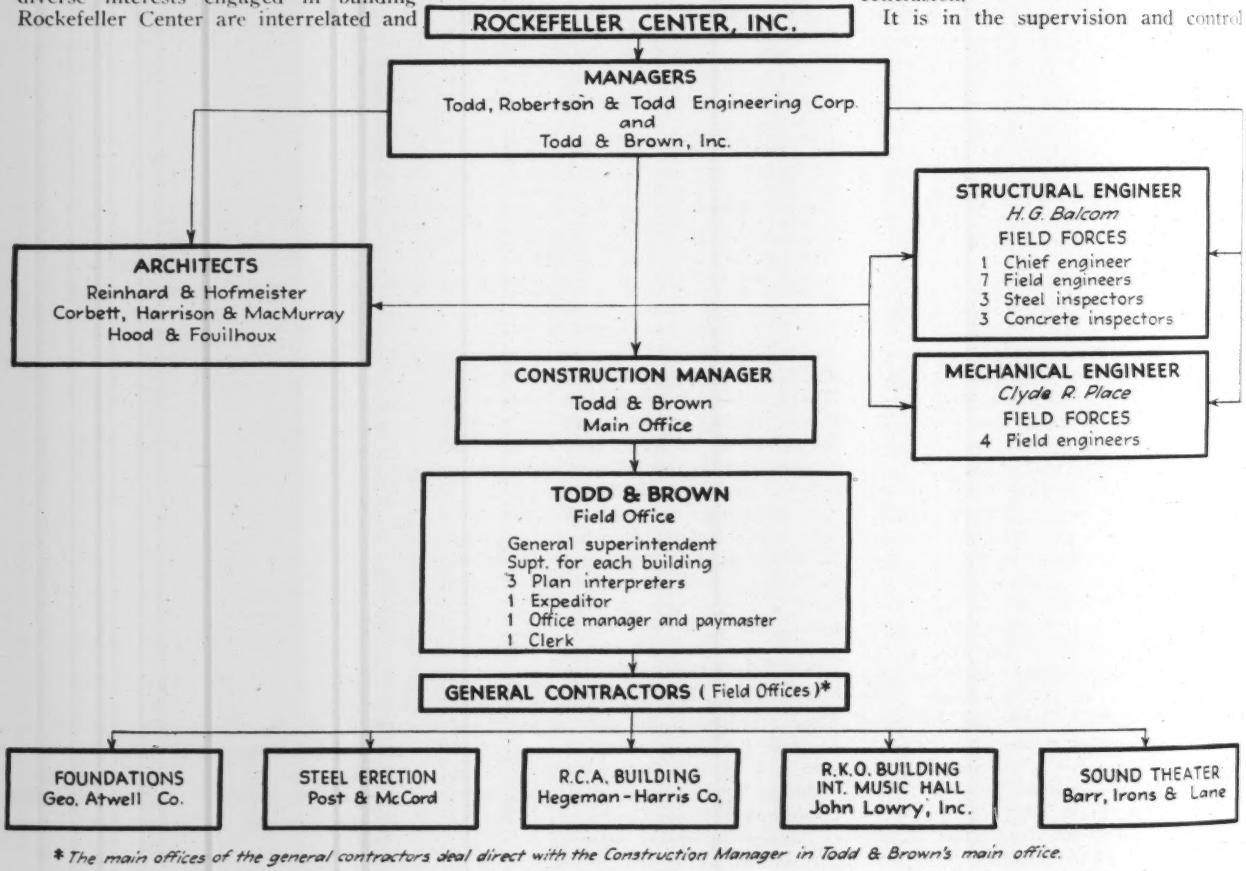
A PLANNING and construction organization adequate for a project of the magnitude of Rockefeller Center obviously must be of unprecedented proportions. The organization that has been drawn up is not only of record size but is in several respects unusual for the building field. Briefly, the special features include an architectural force relieved of the great majority of managerial and field supervisory functions, a financial set-up in which the contractors are financed by the owner, and a field supervisory organization representing the owner that has complete and unquestioned authority. This last arrangement has its sequel on other large construction projects, notably government undertakings such as the Mississippi flood-control work, where army engineers direct the work, and the Hoover Dam, where bureau of reclamation engineers are project managers, but it is a distinct innovation in the building field. The accompanying organization chart indicates how the diverse interests engaged in building Rockefeller Center are interrelated and connected. Analysis of it will show how responsibilities are fixed and supervision and control exercised.

At the beginning of the work the Metropolitan Square Corp., since renamed Rockefeller Center, Inc., was created as a holding company for Mr. Rockefeller. This company engaged the firms of Todd, Robertson & Todd Engineering Corp., and Todd & Brown, Inc., jointly, as managers to take executive charge and to assemble the organization that would carry out the work. In dividing up the managerial functions Todd, Robertson & Todd took over the tasks of broad executive character, including rentals and legal problems, while Todd & Brown assumed charge of engineering construction work, thus providing the contact that not only the ownership but the architects in large degree would have with the field operations. In all other respects the two firms function jointly as managers and have equal responsibility. It is to be noted that while Todd & Brown serve as the architect's field representative in so far as all engineering matters are concerned and handle all contractural relations with contractors, the architects maintain direct field supervision over those materials and elements of construction where architectural considerations are controlling. The structural engineer and mechanical engineer exercise direct field control over their respective functions.

A joint organization of three architectural firms, Reinhard & Hofmeister, Corbett Harrison & MacMurray and Hood & Fouilhoux, was effected, whose sole task is the planning and design of Rockefeller Center. Clyde R. Place was selected as mechanical and electrical engineer, and H. G. Balcom as engineer in charge of structural design.

Planning procedure was not essentially different from that employed on other important work in recent years, in that financial and legal representatives, renting agents, architects, engineers and construction supervisors all had a voice in decisions. This conference method of planning first became general several years ago when the size and complexity of modern skyscraper construction suggested its necessity. On Rockefeller Center, where the usual large-size building operation was several times surpassed, utilization of the conference method was a foregone conclusion.

It is in the supervision and control



* *The main offices of the general contractors deal direct with the Construction Manager in Todd & Brown's main office.*

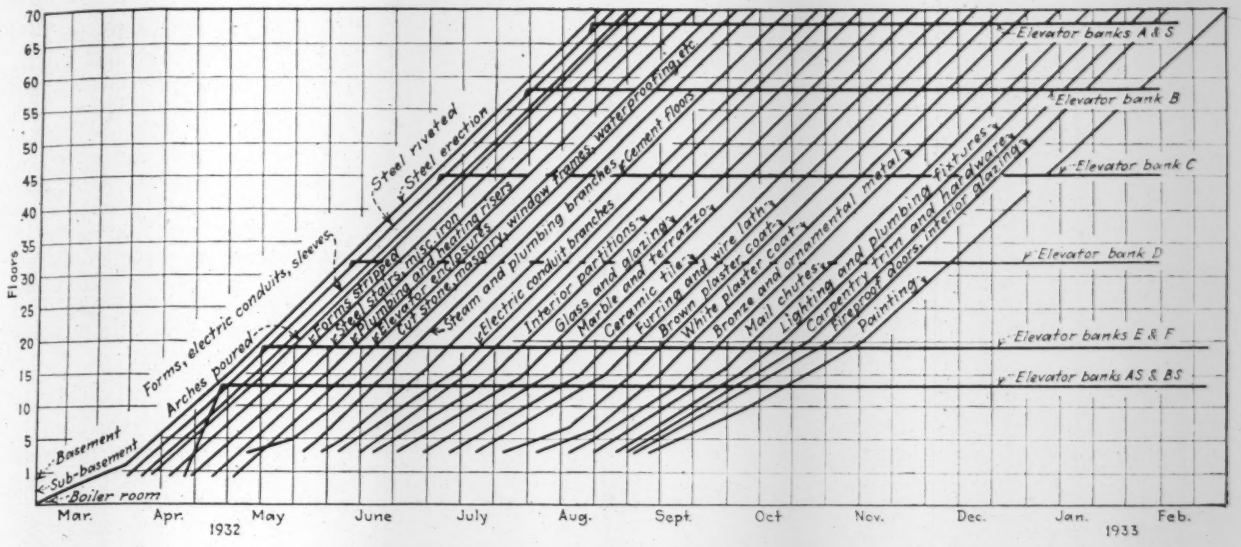


Chart shows progress of each trade or operation. By virtue of the sloping-line characteristic any interference of one trade with another is revealed by an intersection of the respective lines.

of the field work that principal interest lies. Bearing basically upon this supervision is the financial plan in which the three general contractors doing work on the five units under way at the present time are financed by the owning company. These contractors advance no money for the payment of their own men or for the payment of subcontractors. Instead, at the beginning of each month they submit to the managers a statement listing by trades the amount of money spent and the amount required for the next month. A deposit sufficient to cover this requisition is then made in the account of the contractor by Rockefeller Center, Inc., and the contractor can draw on this as it becomes necessary. Since each building budget was made up by trades, these requisition reports serve as a positive check on running costs. In effect, the contract is of the cost-plus-fixed-fee type but with the owners financing the contractors. These contractors thus are subject to the control of the managers. The foundation contractor and the structural-steel contractor whose work covers all of the Rockefeller Center units have straight lump-sum contracts; they finance themselves.

The field force of Todd & Brown includes a general superintendent and a superintendent on each building. These superintendents and the other members of the general superintendent's staff operate somewhat in the manner of consultants. Thus there are several field engineers whose duty it is to interpret plans and specifications and inspect the work of the contractors. All questions relating to these matters that the contractors' field offices may have are referred to the field or main office, as the case may be, of Todd & Brown for its review and determination with the architects. The other important member of the Todd & Brown field staff is the expediter whose job is to supervise material orders and deliveries.

A daily report by each superintendent to the central office of Todd & Brown, listing the number of men at work and the work done by each trade, is supplemented weekly by a letter in which the superintendent reports freely and in whatever manner he wishes on those phases of the work not covered elsewhere. The general contractors' field offices do not report to the central office of Todd & Brown (except for the monthly requisition) but present daily reports to the field superintendents.

The Todd & Brown central office is in charge of a construction manager who has supervisory control of all relations between contractors and the architects and owners. Working drawings and specifications pass from the architects and engineers to his office and then to his field superintendent and to the contractors. Shop drawings from subcontractors and materials-supply companies are routed in the reverse manner, being submitted by the general contractor to the construction manager, from whence they go to the architect for checking and are returned approved through the construction manager to the general contractor.

A special type of progress chart has been worked out, as shown in the accompanying illustration. As long as the parallelism of the lines is maintained no conflict can occur between trades.

Once a month Todd & Brown presents a statement of estimates, authorizations and requisitions to Rockefeller Center, Inc., giving a complete picture of the progressive cost on each building. Inasmuch as the forms give the total amount requisitioned for each trade, the amount needed for the following month and the amount needed for completion of the trade's work, the owner is kept in very close touch with field progress.

While the architects exercise a general supervision from their main office of installations of design and decorative materials, both the structural engineer and the mechanical engineer maintain field inspectors and engineers who report directly to them and to Todd & Brown. In addition to fourteen field men on Mr. Balcom's staff and four on Mr. Place's staff, two architectural representatives for the Metropolitan Life Insurance Co., the lending company, are on the job. Finally, the Travelers Insurance Co. has been retained by the owners to represent the contractors in field injury cases. An important part of this work is the medical department with its fully equipped field hospital and a staff of doctors and nurses. The insurance company also maintains a claims department and a staff of safety engineers.

Steel Erection in Rockefeller Center

IN THE field of buildings few jobs of steel erection compare in magnitude with that carried out by Post & McCord in Rockefeller Center. The problem in the RCA Building was to erect 58,500 tons of steel (about 2½ per cent more than was required in the Empire State Building) in a 69-story skyscraper. In the International Music Hall what was probably the largest assemblage of trusses ever used in building work was erected. The proscenium truss alone weighed 300 tons. In the Sound Theater 65-ton roof trusses were hoisted into place complete. The details of this work were too important to warrant compressing them into the small amount of space available in this issue. The steel erection articles on Rockefeller Center will appear next week.

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Rockefeller Center

IN A TIME when building is almost at a standstill the world over, an enterprise of unprecedented character and size is taking form in that remarkable project known as Rockefeller Center in New York City. Huge as are its dimensions, whether measured in dollars or in steel and stone, these are less significant than the integrated planning on which it is founded. An intensively concentrated community of considerably over one hundred thousand daytime population, closely knit into a complex and yet harmonious commercial unit, will be the result of this planning. This indeed is city planning taken out of the picture-books of the theorists and transformed into reality on hard dollars-and-cents reasoning. Because of the great lesson for all future building-investment practice that lies in this pioneer undertaking, the entire present issue is given up to a compact summary of its major phases. The lesson is to be found in the calculating forethought with respect to long-time values. Such forethought is the very element whose absence has led to city blight and decay. If stability is ever to be attained, forethought like that applied to the present project will doubtless be one of the prime factors.

Precedent Maintained

CONTRASTED with the originality of bulk and space planning and the ingenuity of layout embodied in Rockefeller Center, the structures of this vertical city follow closely the accepted practices of the recent past in respect to the materials used and their manner of combination. Frame, floors, envelope and details are substantially duplicates of what is found in dozens of earlier skyscrapers. This fact stands as a strong endorsement of structural practice, and suggests that structural engineers and builders have developed their methods to a high state of perfection. There is still large opportunity for better building methods based on new materials, in the direction of reduced weight, readier installation, lower cost and maintenance, but it appears that present-day builders are using fully and effectively the materials made available by the manufacturing arts. What chemical technology has in store for the future betterment of building construction will have to win its way against building practices of well-proved efficiency.

Skyscraper Plumbing

UNDER ordinary conditions the property line is considered the boundary of the engineer's legitimate field in water-supply and sewerage practice. Everything beyond that line is in the plumber's province. It is otherwise when the property being serviced is a skyscraper, for here the hydraulic problems assume considerable magnitude. A modern tall office building requires several miles of water-distribution mains, and water waste may be as serious an economic loss as it would be in a medium-sized town. Soil pipes may attain sizes that make them comparable with the sewers of many cities. It is obvious that the principles of engineering must be called upon in designing plumbing systems of this character. The RCA Building in Rockefeller Center affords an excellent example of modern skyscraper plumbing. The article on the subject in this issue should interest sanitary engineers; structural engineers whose design problems are affected by plumbing requirements should also find it instructive.

An Election Result

THE PASSING of election day brought to an end many uncertainties that checked business progress. But if the election removed uncertainties in the public mind, it tended to introduce much uncertainty into the governmental machinery at Washington and the state capitals, for there is sure to be extensive shifting of major political officials, and this may threaten the stability of many of the working departmental organizations which carry on the public's business and which are in no way political, either in set-up or philosophy. Disruption or weakening of these staffs would be a serious loss to the country, for they are in general devoted and efficient working groups. The stable and successful management of the country's public affairs depends wholly on these departmental staffs, and the less they are disturbed the better for the welfare of the community. There has been so much loose talk about government waste, inefficiency and extravagance as to give newly elected officials and their directing appointees ready opportunity for extensive tearing down and rebuilding of department organizations. In the present state of business such action would be disastrous.

Last Obstacle Removed

THE LAST obstacle to the start of construction of the Los Angeles-Colorado River aqueduct was removed last week when the supreme court of the District of Columbia dismissed an injunction suit brought to restrain the Reconstruction Finance Corporation from loaning $40,000,000 to the Metropolitan Water District of Southern California. Justice Luhring of that court ruled that as the question of the legality of the district's bonds already had been passed upon by the supreme court of California, his court was without jurisdiction. He said further that the parties bringing the suit were not sufficiently interested in the aqueduct construction to be parties to such a suit. This is a very satisfactory outcome of a last-minute attempt to stop a great project that has been under discussion for sufficient time to permit those who have opposed it to put their views before the public. Had money-market conditions been normal, the water district could have sold its bonds locally; the fact that it had to come to Washington for a loan from the R.F.C., therefore, should not be permitted to open a new avenue of attack to opponents of the undertaking. The district is taking bids on the first part of the work to be put under contract. As the majority of the people of the district will appear to want to go ahead with construction of the aqueduct, they should be permitted to do so.

Make Waterways Pay

MUCH is being said in these days on the advantages of waterways; they are held up as a means of cutting down distribution costs and as a source of work for the unemployed through improvement of existing channels and the opening of new ones. It is taken for granted that they are a paying investment. On the other hand, Frederick Stuart Greene, director of public works of New York State, with characteristic frankness asserts that the state's barge canal is an expensive luxury. The same thing has been said of other canals, both abandoned and still in use. With the present tendency toward making public utilities self-supporting, should not waterways be asked to show that they can meet their costs?

The subject is of immediate timeliness. Recently a treaty looking toward the construction of a new canal down the St. Lawrence River from Lake Ontario to Montreal was signed by representatives of the two governments concerned. Discussion of that treaty as it comes before the U. S. Senate for ratification is sure to be highly controversial, but it is unlikely to rest on economic facts and proof, for waterways are a theme of emotional attitude and political propaganda. Soon also the waterway across Illinois connecting the Mississippi River with the Great Lakes at Chicago will be completed. So far it has been a source of heavy expense not only to the state—which recently got the federal government to undertake its completion—but also to cities and the railroads with which it will compete.

Unfortunately, the cost of waterway operation cannot be analyzed as exactly as the operation cost of a railroad, for example, can be analyzed. The indirect costs are rarely known. The indirect benefits—assumed to represent potential revenue—must be included; and when indirect costs or benefits enter there is no limit to possible difference of opinion.

No extended argument is needed to demonstrate that a great barge loaded with coal or steel can move down the Ohio and Mississippi rivers from Pittsburgh to New Orleans at less cost than for movement of the same products in cars on rails, or that oil can be sent from Bayonne, N. J., to Buffalo, N. Y., in barges via the Hudson River and the barge canal more cheaply than in tank cars, *if only the immediate operation costs are considered.* But when an attempt is made to determine and fix upon the individual shipment its share of the cost of constructing, maintaining and operating the waterways, then the calculation becomes quite different and highly complex. Shall the annual interest and amortization charges on the state or federal investment in the project plus operation and maintenance costs be charged proportionately against each ton of freight moved during the year, or shall part of these costs be charged to current federal and state expenditures and part passed on to future generations on the grounds that the waterway is still in the development stage and that, therefore, the major benefits will come to them? In short, shall waterways be subsidized, in the hope that future earnings will repay the subsidy? The traffic that now moves on artificial waterways is subsidized and has been developed as the result of a subsidy. That fact is indisputable. How, then, may we appraise the economic value of any particular waterway?

Until this country adopts a policy of making the traffic that moves over its inland waterways pay operating and maintenance costs, and at least a reasonable share of construction costs, as is attempted for highways through motor-vehicle and gasoline taxes, we will never know whether the waterways are economically justified. And this is a question of utmost seriousness today, when transportation systems are in a highly demoralized condition. Serious attempts are being made to set up a proper economic balance between railway and motor-vehicle operation. Unless the same is done with waterway operation, our transportation system cannot reach a sound economic basis.

Chicago Tax Muddle Clearing

FOR MONTHS the city of Chicago and all other municipal governments in Cook County have been stoking the fires of public service with paper boxes. Every possible fund has been emptied of cash and replenished with tax-anticipation warrants. The expedient was unavoidable under the circumstances, tax collections being two years behind and tax-strike associations busying themselves filing legal objections to $200,000,000 of assessments. Few private corporations could hold together their personnel or maintain any service whatever in a like situation.

Fortunately, this condition bids fair to clear from now on. A recent state supreme court decision confounds the tax strikers and essentially throws out of court their contention that the real estate assessments were illegal because personal property had not been adequately returned.

The latest move, and one calculated to bring home to the delinquent a realization of what government service really means, is to curtail the service privileges of those who have not yet paid but who are able to pay their taxes. This is done because the volume of delinquency is so great that the usual threat of tax buyers bidding in the property is ineffective; there are no tax buyers. The commissioner of public works has been authorized by city council to shut off the water from delinquent premises. Other privileges are to be revoked, such as permits for switch tracks, canopies, signs and no-parking permits. Discontinuance of garbage and ash collection is not contemplated; the water threat should prove sufficient, for without water no apartment could be occupied nor office space rented.

The new tax-assessment roll, on which the levy for 1931 is yet to be made, is now approaching completion. The money was spent long ago, but the collection will permit taking up the 1931 tax warrants and substituting for them those of a later date. The hopeful fact that the wheels are moving will facilitate further financing.

So long as actual operating cash must be raised through the medium of anticipation warrants and but 75 per cent or less of warrants may legally be issued, the citizen of Chicago must resign himself to drastic reduction of municipal services. Additional police and fire protection, both badly needed, cannot be provided. Bond-interest payments must be met or the city proper, which has heretofore not defaulted, will impair its credit for two or three decades to come as the county, the sanitary district and numerous park boards already have done. The situation looks deplorable to the outsider, but it is so much better than it has been that the dawn of better days now seems a reasonable possibility. In the meanwhile an army of loyal officials and employees is still months behind in salary checks. The continued loyalty of these men to their tasks is one of the things to which tribute will be paid in better days.

NEWS OF THE WEEK

R.F.C. Approves $1,665,000 Loans for Water Projects

FOUR loans totaling $1,665,000 were approved by the directors of the Reconstruction Finance Corporation during the past week. The largest of these was for $1,125,000 to the Twin Lakes Reservoir and Canal Co. of Olney Springs, Colo. for a 4-mile canal, a tunnel 3.8 miles long under the Continental Divide and an increase in the company's reservoir capacity from 54,000 to 70,000 acre-ft. The company is a mutual non-profit organization supplying water to the towns of Olney Springs, Crowley, Ordway and Sugar City. It also furnishes water for irrigation. Recent droughts have indicated that the company must increase its supply. The most available source is west of the divide. The proposed tunnel will be 9 ft. in diameter, lined in part. The R.F.C. will buy 6 per cent bonds.

Sanford, N. C. is to receive $45,000 through the sale of 6 per cent bonds to the R.F.C. The money will be used to construct a filtration plant of 1,000,000 gal. per day capacity, also for construction of a storage reservoir formed by an earth dam 300 ft. long.

Reservoir construction in Texas

The R.F.C. will make a loan of $450,000 to the Tarrant County (Texas) Water Control and Improvement District No. 1, Fort Worth, Texas, for which the district will pledge $495,000 of its 5 per cent bonds. About $4,500,000 already has been expended on the construction of reservoirs and levees. The R.F.C. money will be spent for railway relocation and the completion of two reservoirs. The reservoirs will completely regulate 36 per cent of the drainage area of the Trinity River above Forth Worth. Sale of water to Fort Worth will make the loan self-liquidating.

West Monroe, La., is to receive $45,000 for the extension of its water supply system and for sinking of a new well. The R.F.C. will buy its bonds. Passage of an ordinance changing the bond dates is required.

Loan applications

Application has been made to the R.F.C. for a loan of $15,000,000 for an irrigation project on the Verde River, north of Phoenix, Arizona.

The Central District, Inc. is reported to have applied to the R.F.C. for a loan of $10,000,000 for a port terminal on Newark Bay at Bayonne, N. J.

Pensacola, Fla. plans an application for a loan of about $40,000 for extensions to its water distribution system.

Wetumka, Okla. has applied to the R.F.C. for a loan of $30,000 to finance a natural gas supply system and plans to ask for $15,000 for a water supply system.

Construction of a 10x10 ft. tunnel 30,600 ft. long to serve mining properties in the Bingham mining district, Utah, is proposed by the Bingham Tunnel & R.R. Co. of Salt Lake City. Application for an R.F.C. loan is planned. An application for a certificate of convenience and necessity is now before the state utilities commission.

Belleville, Ill., proposes to ask the R.F.C. for a $1,500,000 loan for a municipal water supply system.

Wellington, Utah, plans to apply for a $25,000 loan to replace its wood pipe distribution system with cast iron pipe. Leeds, Utah, seeks $60,000 for improvements to its distribution system; Escalante seeks $30,000 for a new system; Levan seeks $25,000 for a chlorination plants and new pipes; and Salem will apply for $60,000 to extend its distribution system. The Utah state department of health is aiding in the preparation of these applications.

New pumping plant proposed

A. A. Sprague, commissioner of public works, Chicago, has submitted to the finance committee of city council a plan, worked up by Myron B. Reynolds, city engineer, looking toward the replacement of three antiquated and inefficient pumping stations with a single modern station costing approximately $3,000,000. Relocation of mains would cost another $1,000,000. It is proposed to obtain the funds from R.F.C. as the project will be self-liquidating and effect a net saving of at least $125,000 per year over the present stations besides greatly strengthening the system and increasing the service.

Construction of an airport to cost $5,841,000 at Miami, Fla. is proposed and the city manager has been authorized to apply to the R.F.C. for a loan. The airport would be an island in Biscayne Bay.

Wyandotte, Mich. will apply to the R.F.C. for $200,000 to complete the city's new boiler plant. Grosse Ile, Mich., is making preparations to apply for $140,000 for a new water supply system.

Private funds available

Eau Claire, Wis., which in September made inquiry of R.F.C. as to eligibility of a new $700,000 well supply project, has learned that it probably can obtain funds through the regular financing channels at a lower per cent rate of interest than the 6 per cent which the R.F.C. has usually demanded for projects of this kind. The project depends on tests not yet completed to obtain wells free from iron and manganese, two such test wells being equipped with pumps which can be used in the permanent installation.

Action delayed

Seattle, Wash., is not expected to take up the R.F.C. loan of $1,491,000 for additions to its water supply system until after the water department's books are audited or until about Jan. 1. Meanwhile the city plans to sell $500,000 of a $1,000,000 bond issue to finance current construction needs.

Application of the Chamber of Commerce of Helena, Ark. for a $2,000,000 loan for a bridge across the Mississippi River has been denied by the R.F.C. Application of the Niagara Frontier Bridge Co. for a $5,000,000 loan for bridges to Grand Isle also has been disapproved.

Sanitary District Blames Delay on Chicago Tax Tangle

LACK of funds, a consequence of the involved state of tax collection in Cook County, was given by the Sanitary District of Chicago as the main cause of its delay in carrying out its program of sewage plant construction in its answer to the United States Supreme Court's recent demand that it show cause why it has not taken appropriate steps to comply with the requirements of the court's decree dated April 21, 1930. The court order to the Sanitary District followed the filing of complaints by Wisconsin, Minnesota, Ohio, Pennsylvania, Michigan and New York and an application for the appointment of a court officer to carry out the requirements of the decree.

On April 1, 1930, the court approved the recommendations of the Special Master sitting in the Chicago diversion case relating to the limitations to be put on the quantities of water to be diverted from Lake Michigan. These recommendations were that the amount diverted, in addition to the water used for domestic purposes, should be limited to a maximum of 6,500 sec.-ft. after July 1, 1930, to a maximum of 5,000 sec.-ft. after Dec. 31, 1935, and to a maximum of 1,500 sec.-ft. when the whole system of sewage treatment is completed which was expected to be accomplished before Dec. 31, 1938.

Order not disregarded

In its reply to the court the Sanitary District submits that it has complied with the terms of the decree that followed on April 21, 1930. The reduction in diversion of water from Lake Michigan to an annual average not exceeding 6,500 sec.-ft. was made on July 1, 1930. Since that date the diversion has average 6,497 sec.-ft. for the last six months of 1930, 6,500 sec.-ft. for the year 1931 and 6,415 sec.-ft. for the first ten months of 1932. It further submits that the decree contains no specific requirement concerning a program of construction, although the court in its opinion approved the recommendation of the Master that the whole system of sewage treatment work should be completed by Dec. 31, 1938.

Prior to the entry of the decree the engineers of the Sanitary District had estimated that 12 years were required for the completion of works of sufficient capacity to treat the sewage originating within the boundaries of the Sanitary District so as to permit the reduction of water diversion to 1,500 sec.-ft. without undue pollution of the water below the south end of the sanitary canal. The program of construction that was adopted included 250 miles of intercepting sewers, five sewage treatment plants, several pumping stations and controlling works for the Chicago River. In accordance with the progress on that program 31.6 per cent of the sewage of the district was being treated on July 1, 1932. Since the date of the decree contracts

totalling $13,636,000 have been let. At the present time uncompleted work which is actually under contract amounts to $8,793,000. Work for which plans and specifications are completed and which is ready immediately to advertise for bids amounts to about $2,500,000.

The Sanitary District is said to be a special sufferer from the non-payment of taxes and delay in their collection. Due to a revision in the methods of assessing taxable properties, legal action directed against the assessments when they were completed, tax strikes and an epidemic of bank failures in Chicago, large amounts of taxes which the district should have received are unpaid. For more than two years no tax revenue was received at all. On Oct. 26, 1932, 24 per cent of the 1928 tax levy was still unpaid, 30 per cent of the 1929 levy, 45 per cent of the 1930 levy and the 1931 levy had not yet been put into collection. An aggregate of $41,105,000, equivalent to two years taxes, were past due and unpaid to the Sanitary District up to Oct. 26, 1932. The non-payment of these taxes left the district without means to pay bond interest and maturing principal on its outstanding bonds and resulted in defaults which on Nov. 1, 1932, amounted to $10,972,135.

The district was forced to suspend payment to its contractors on Nov. 1, 1931, with the result that practically all contract work has stopped. Regular payments were suspended on salaries to employees on Nov. 15, 1931. Measures have been taken to reduce expenditures to the minimum, consistent with the continuance of necessary activities. Forces have been drastically reduced. All salaries have been reduced from 10 to 20 per cent and employees are being paid only a portion of their salaries at irregular intervals. Efforts of the district to market its bonds have failed completely.

In addition to the financial breakdown, the failure of the War Department to approve the plans submitted to it for controlling works in the Chicago River is cited by the district as a further cause of delay.

Other factors operating against the orderly completion of the district's program of construction include the opposition of property owners to the site selected for the Southwest Side treatment works and the opposition of the stockyards industries.

Diversion Starts at Hoover Dam

Diversion of the Colorado River from its normal channel into the by-pass tunnels in the canyon walls was begun on Nov. 13. Work on the cofferdams in the river has been in progress for some time and the river, now at a low stage, had been diverted to one side of its channel in preparation for the diversion to the tunnels.

This diversion marks the completion of the first stage of the work, which is now a full year ahead of schedule.

Special Assessment Work Ineligible for R.F.C. Loans

An opinion dealing with the differentiation between assessments and taxes in their application to self-liquidating projects has been drawn up by the legal division of the Reconstruction Finance Corporation. The opinion follows:

"It is the view of this corporation that sidewalk, pavement, sewage and other special assessments usually constitute taxation. In fact, it has been earnestly urged upon the corporation that such assessments are not only taxes but that they are possibly the most obnoxious form of taxes.

"In this connection, however, it may be helpful to you to point out that under the laws of many states, municipalities are permitted to impose charges for the use of their sewers quite similar to those that are imposed for water or electric current In some cases, householders are charged a flat rate per month or per year. In others, the charge is based either in proportion to the amount of water consumed by the sewer user or on the basis of the size of the sewer connection.

"Charges of that kind are analogous to tolls, fees and other charges of the type that are authorized means for repaying the construction cost of self-liquidating projects. If the statutes or ordinances provide for charges of that kind to be made against the persons who use the sewers or other facilities and if the amount of such charges is adequate to make the project self-supporting and to return its construction cost within a reasonable time, the projects are eligible for loans from this corporation."

New Bids Called for Dam of Flood Control District

New bids on construction of the proposed Dam No. 1 of the Los Angeles, Calif., county flood control district project in San Gabriel canyon will be opened Dec. 19. Bids on Dam No. 1 have been opened twice before and rejected on the grounds the lowest bid was too much above the estimate of E. C. Eaton, chief engineer of the county flood control district. The county board of supervisors on Nov. 7 formally accepted new specifications for the proposed dam, which is expected to cost approximately $10,000,000. The date of opening the bids was set ahead six weeks instead of four to afford the contractors who have submitted bids on the tunnel work for the Metropolitan Water District project plenty of time to get back their bidders' checks before bidding on the county work. The bids on the Metropolitan Water District Colorado River aqueduct project will be opened Nov. 29. The amount required with bids on the Metropolitan Water District work is close to $400,000 and the amount that must be put up with each bid on Dam No. 1 is approximately $300,000.

Right to Order Sewerage Work by Ohio Board Questioned

The right of the Ohio Department of Health to compel the construction of adequate sewage disposal facilities where bond issues to finance the work have been rejected by the voters is being tested by the city of Van Wert, Ohio, in a case now before the state supreme court. Recently the voters disapproved a proposed bond issue of $250,000 for the construction of a sewage disposal plant which the Ohio Public Health Council had ordered built. The Department of Health maintained that a municipality cannot endanger the health of other communities merely because voters reject an extra levy.

Upon the decision of the supreme court hangs action by other cities on like orders of the health departments, including Columbus, Bowling Green, Bedford, Maple Heights, New Bremen and Bucyrus.

NEW MISSISSIPPI RIVER BRIDGE OPENED TO TRAFFIC

A new bridge over the Mississippi River between Moline, Ill., and Arsenal Island, the site of the Rock Island arsenal, was opened on Oct. 15. The bridge, including approaches, has a total length of 2,033 ft. The arches have a clear span of 140 ft. and an under-clearance of 41 ft. 8 in. over the navigable channel. The structure cost $209,500. It was built under the direction of the commanding officers stationed at the Rock Island arsenal during its construction, Col. David M. King and Col. H. W. Schull; Sverdrup & Parcel, St. Louis, were the consulting engineers and the contractor was Woods Brothers Construction Co.

More Large Government Contracts for Federal Work Approved

Five large contracts for river and harbor work were approved by the Chief of Engineers on Nov. 10 and the Quartermaster-General approved five contracts for housing work at army posts.

The larger of the river and harbor contracts was one of $1,190,251 to the Vang Construction Co. of Pittsburgh for the construction of locks and dam No. 2 on the Allegheny River in the Pittsburgh district. The same company received a contract for lock No. 3 at $512,444. A contract for dredging and clearing right-of-way along the intracoastal waterway between the St. Johns River and the Tolomato River in Florida went to the McWilliams Dredging Co. of New Orleans for $310,140. A contract for dredging in the Cape Cod Canal went to the Great Lakes Dredge & Dock Co. of New York for $171,215.

T. A. Loving & Co. of Goldsboro, N. C., received a contract of $138,049 for the construction of officers and non-commissioned officers quarters at Pope Field, N. C., and the Reinecke-Dixon Construction Co., Fayetteville, N. C., received a contract for $103,310 for like construction at Fort Bragg, N. C.

On Nov. 12 the Quartermaster-General approved nine contracts for army post work, the largest of which was $223,100 to the Henry B. Ryan Co. of Chicago for the construction of a post hospital at Barksdale Field, Shreveport, La., and a contract of $106,700 to George E. Wieland of San Antonio, Texas, for the construction of officers quarters at Fort Smith, Texas.

Contracts totalling nearly $200,000 went to the M. A. Long Co. of Baltimore for post hospitals at Fort Howard, Md., and at the Holabird Quartermaster Depot at Holabird, Md.

Five contracts for river and harbor work were approved by the Chief of Engineers on Nov. 12. One for $980,167, went to the Construction Materials Corp. of Chicago for dredging in the Ballards Reef Channel in the Detroit River, another for $123,509 went to the Atlantic, Gulf & Pacific Co. of New York, for dredging in the harbor at Bridgeport, Conn., and a third went to the Vang Construction Co. of Pittsburgh for dredging in the Huntington district.

An allotment of $550,000 of the money provided for river and habor work under the Emergency Relief and Construction Act for the repair of jetties at Yaquina Bay, Ore., was approved by the acting Secretary of War on Nov. 12.

An allotment of $525,000 for the construction of locks and for dredging in the New Orleans-Sabin River section of the intracoastal waterway was approved by the action of the Secretary of War on Nov. 9. The work on the waterway is actively in progress at several points. It will have a depth of 9 ft. at mean low water and a bottom width of 100 ft.

Contract Let for Big Cableway

A contract for the 150-ton capacity cableway spanning the Colorado River at Hoover Dam has been awarded to the Lidgerwood Manufacturing Co., Elizabeth, N. J., for $172,910. A description of the cableway was published in *Engineering News-Record*, Oct. 6, 1932, page 408. It will have a span length of 1,250 feet.

Washington Notes

By Paul Wooton
Washington Correspondent

ONLY opponents of the Great Lakes-St. Lawrence deep waterway project had been heard at the time of this writing. The principal points made were that the project has not been adequately studied and that ratification of the treaty at this session would be premature; that the cost would greatly exceed the estimate; that structures built with American money would become Canadian property; that probable benefits have been exaggerated and that it would add a large amount to the national tax burden.

E. P. Goodrich, consulting engineer for the Albany Port District Commission, was authority for the statement that steam power can be generated and distributed throughout New York and New England more cheaply than can the power to be developed in the St. Lawrence River. He estimates that it would take 20 years to absorb the power that will be brought in. His estimate of the cost of the project is $1,054,457,000, as compared with the official estimate of $543,429,000. Even on the official estimate the overhead costs during the life of the bonds, he figures, will be $27,171,450 per year.

Peter G. Ten Eyck, president of the New York State Waterways Association, testified that "if all the grain which was exported through North Atlantic ports in the maximum year of 1922 had been transported through the improved St. Lawrence route the interest charge alone would be at the rate of 14½ cents per bushel."

Alfred P. Thom, general counsel for the Association of Railway Executives, objected to the establishment of a subsidized service to compete with rail carriers. The tonnage diverted, he told the committee, would result in unjustifiable injury to the railroads. The proposed waterway would furnish an incomplete service, he said, since climatic conditions limit its use to six and one-half or seven months out of each year. "If the United States would pay annually to the railroads the amount it would have to pay annually for interest charges, maintenance and operation of the waterway, the railroads could afford to haul free all the grain that would move from the United States through that waterway," Mr. Thom told the committee.

Numerous Check Dams to Be Used in San Gabriel Flood Control

Construction of approximately 1,900 small check dams in the San Gabriel canyon watershed as a means of water conservation and flood debris control has been approved by the Los Angeles, Calif., county board of supervisors upon submission by E. C. Eaton, district flood control chief engineer, of a survey report. The report recommended construction of 177 rock and wire dams and 1,722 loose rock dams. None of the dams would be of large size. The report said the program would cost about $260,000, including cost of construction of 86 miles of trails in the canyon watershed. The trails also would serve as firebreaks and motor trails for fire fighting. The board of supervisors immediately appropriated $25,000 for building the trails, work which will employ about 300 men for several months.

Los Angeles Aqueduct Loan Suit Rejected by D. C. Court

The suit brought in the supreme court of the District of Columbia by a group of citizens of Southern California to keep the Reconstruction Finance Corporation from lending $40,000,000 to the Metropolitan Water District of Southern California for the Los Angeles aqueduct was dismissed by that court on Nov. 8, as noted briefly in our issue of last week. The court held that in view of the fact that the supreme court of the State of California had already passed on the validity of the bonds, it had no jurisdiction. Further, it held that the petitioners did not have sufficient interest in the undertaking to permit of their becoming parties to such a suit.

The few remaining steps which must be taken before construction of the aqueduct is launched will be disposed of with all possible speed, according to W. P. Whitsett, the district's chairman, in a statement commenting on the dismissal of the suit.

"The district is preparing to push forward the necessary proceedings incidental to the sale of a block of Colorado River aqueduct bonds in the amount of $1,016,000 and to carry forward, as rapidly as possible, all other steps leading to the actual launching of construction on the great aqueduct project," Mr. Whitsett said.

Cook County Road Funds Diverted to Unemployment Relief

Passage of the $20,000,000 unemployment relief bond issue Nov. 8 in Illinois to be serviced by the one cent share of the state's collection of three cents on each gallon of gasoline means that one-half of Cook County's one cent will be required for a period of 20 years. The state legislature has passed a bill permitting the county commissioners to allot the remaining portion of the one cent, amounting in Cook County to $150,000 per month to direct dole.

Strenuous objection is being made to this total diversion of gas tax by oil, material and machinery interests. The county board is split on the matter, those opposing the measure claiming that contracts will be abrogated and many road workers thrown into the dole lines.

Lake County has approved the diversion of $100,000 of its apportionment to poor relief of the 20,000 destitute in the county.

Welding Course to Be Continued

A course of training in designing for arc-welded construction recently given by the John Huntington Polytechnic Institute in Cleveland in cooperation with the Lincoln Electric Co. is to be repeated at intervals through the winter season. The course consists of a week's intensive work, six days being spent in the operators' training school of the Lincoln Electric Co. and the evening devoted to lectures in the institute.

Enrollment is limited to 30 men and applicants must be college graduates in engineering or men having equivalent practical experience.

Information concerning the course may be obtained from Alfred Mewett, dean, John Huntington Polytechnic Institute, Cleveland.

Michigan County Rushes Work to Provide Winter Employment

Determined to relieve the unemployment situation this winter by retaining as many workers as possible during the fall and winter months, the Wayne County (Mich.) Road Commission is planning a program of bridge and grade separation construction to the limit of its finances.

Under the provisions of an act of the state legislature, 272 miles of township roads have been taken over by the county for improvement and maintenance and the bridges on these roads are in the main too narrow and too lightly constructed for present-day traffic requirements. The commission, therefore, has adopted a policy on the township roads of providing a 30-ft. clear roadway bridge, and wherever feasible it will build a reinforced-concrete deck girder bridge, which lends itself to future widening whenever such need arises, with little sacrifice of the original investment.

Work is also to be started at an early date to separate the grades at the Pere Marquette R.R. crossing and Six-Mile Road. Work is also under way to lengthen the Pennsylvania R.R. bridge over the Outer Drive in Allen Park. Other projects are the widening of the bridge over the Huron River at Flat Rock on Telegraph Road, and the removal of the pony truss bridge spanning the River Rouge on Telegraph Road an its erection on Lilley Road near the Michigan superhighway.

Income from Hudson River Bridge Shows Considerable Profit

The net income from traffic over the George Washington Bridge at New York during the first year of its operation which ended on Oct. 25 was stated by the Port Authority to be about $1,200,000. This figure is approximate as the Port Authority's accounting is on the basis of the celendar year. Figures for the first nine months of the year 1932 have been furnished this journal by the Port of New York Authority. They are as follows:

TRAFFIC	
Passenger automobiles	3,837,141
motorcycles and bicycles	10,780
Trucks, tractors and trailers	178,485
Buses	172,046
Total	4,198,452
INCOME	
Gross Income	
Operating revenue	$2,233,934
Rent	61,882
Miscellaneous income	21,794
	$2,317,610
Deductions	
Operating expenses	$244,597
Interest on funded debt	1,063,318
Miscellaneous	261
	1,308,176
Net income	$1,009,434

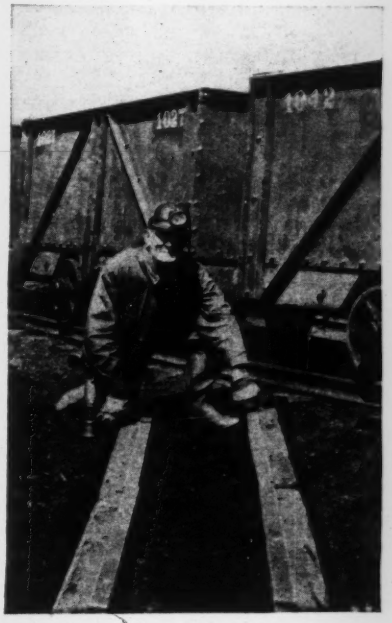
On the basis of these figures for the first nine months of the year, the total traffic over the bridge for the entire year should be close to 5,600,000 vehicles. Estimates of the traffic during the year 1932 made before the bridge was built placed the total for the year at 8,645,000 vehicles. However, despite the fact that the traffic falls short of the estimate, the bridge has met operating and interest charges for 1932. Payments on the sinking fund do not begin under the financing schedule until 1935 and, apparently, interest charges will be higher in subsequent years.

Holland Tunnel Traffic Declines in Fifth Year

Traffic through the Holland Tunnel under the Hudson River at New York for the fifth year of its operation amounted to 11,636,446 vehicles or about 8 per cent under the record of last year. Net earnings, however, for the year will amount to over $2,600,000.

The tunnel was opened Nov. 13, 1927. During the first year 8,517,689 vehicles used the tunnel; during the second year, 10,766,251; during the third year, 11,927,393; and during the fourth year, 12,680,807. Had the rate of increase in the two years previous to last year continued, the traffic this year would have been close to 13,700,000. This would indicate a total falling off of about 15 per cent of what might normally have been expected.

A classification of the traffic for the fifth year shows that the tunnel was used by 9,282,934 passenger cars, 398,595 buses and 1,954,917 trucks. Comparing these figures with the figures for the previous year shows that the decline in traffic was almost entirely in passenger cars, that the falling off in truck traffic amounted only to 49,000 vehicles and the falling off in bus traffic was negligible.



REMAINS OF OLD UNDERGROUND RAILWAY BROUGHT TO LIGHT

The remains of one of the oldest underground railways in this country were found recently in the Thomaston Section of the Pine Knot Colliery of the Philadelphia & Reading Coal & Iron Co.

Records of the company indicate that the rails were laid in 1840, four years after the company was established, hence they have been underground nearly a century. The track had a gage of 44 in., the same as is still used in the Pine Knot Colliery. The iron part of the rails was found to be in good condition despite long exposure to sulphur water in the mine. Analysis indicated it to be puddled iron.

The rails are formed at angles with 2-in. legs about ½-in. thick mounted on squared hand-hewn timbers and held in place with small iron nails. Heavier iron spikes held the wooden rails to cross ties.

Low-Cost Road Construction Subject of Asphalt Conference

Recent developments in the construction of low-cost roads with the maximum use of local materials, developments in methods for resurfacing old roads, farm relief through farm-to-market roads, and the menace of gasoline tax diversion, are among the subjects to be discussed at the tenth annual asphalt paving conference to be held at New Orleans Dec. 5-9 under the auspices of the Asphalt Institute and the Association of Asphalt Paving Technologists. Adoption of a 1933 program looking toward the construction of feeder roads for the railroads rather than parallel roads also will be considered.

Among the speakers will be Thomas H. MacDonald, chief of the Bureau of Public Roads, S. S. Lewis, Pennsylvania highway department; C. S. Pope of the California highway department; O. W. Merrell, Ohio highway department; W. H. Foushee, North Carolina highway department; W. V. Buck, Kansas highway department; and Elmer Lawton of the New York State highway department.

Closer cooperation between highway departments in this country and in Canada will be discussed by Leopold Macaulay, newly appointed Minister of Highways of Ontario. Development of asphaltic road practice in Canada will be discussed by R. M. Smith, deputy minister of highways in Ontario.

Loan Sought for Bridge Work

The Vicksburg Bridge & Terminal Co. has applied to the Reconstruction Finance Corporation for a loan of $4,000,000 to liquidate its present bonded indebtedness and to replace a temporary 1,071-ft. pile trestle with a permanent steel trestle on concrete footings as required by the War Department. The company, which is not now a common carrier, also has asked permission from the Interstate Commerce Commission to operate over the trackage on its bridge between Delta, La., and Vicksburg, Miss. The Yazoo & Mississippi Valley R.R. now leases the tracks from the bridge company. The loan from the Reconstruction Finance Corp. is desired for a term of 3 years and would be secured by a like par amount of the company's first mortgage 6 per cent gold bonds.

Method of Obtaining Relief Funds Described in New Pamphlet

A pamphlet giving information on federal funds available for emergency unemployment relief work and setting forth the proper manner to go about obtaining such funds has been prepared and is being distributed by the National Committee for Trade Recovery and the American Society of Municipal Engineers. Copies may be obtained from the local offices of the Trade Recovery committee, from its main office, 330 W. 42nd St., New York, or from C. W. S. Sammelman, executive director, American Society of Municipal Engineers, 4359 Lindell Boulevard, St. Louis, Mo.

The pamphlet includes a model act for legislation required to put sewerage works and waterworks on a self-liquidating basis under the rules of the Reconstruction Finance Corporation. Current practice in service charges for sewage collection and disposal is outlined.

Rear Admiral Frank Chambers, Navy Civil Engineer, Dies

Rear Admiral Frank Taylor Chambers, Civil Engineers Corps, U. S. Navy, died in Washington, D. C., on Nov. 9, following a long illness. Admiral Chambers was a native of Louisville, Ky., and graduated from the Rensselaer Polytechnic Institute as a civil engineer in the class of 1892. After graduation he joined the structural steel department of Snead & Co., iron works, Louisville, and three years later joined the engineering staff of the Pittsburgh Bridge Co. In 1896 he entered the structural steel department of the office of the Supervising Architect, Washington, D. C. The following year he won a competitive examination for a commission in the Civil Engineers Corps., U. S. Navy, was appointed immediately and assigned to the New York navy yard.

Admiral Chambers served on the Chesapeake & Delaware Canal Commission in 1905-06 and as a member of the Army and Navy Board in 1908. During the World War he was in charge of construction at the naval operating base at Hampton Roads, Va., until January, 1918, when he became chief engineer of the Port Facilities Commission of the U. S. Shipping Board.

City Planners Discuss Problems in Public Property Acquisition

Urban land policy was the theme of the annual meeting of the American City Planning Institute held in Pittsburgh, Nov. 13, 1932. The papers presented brought forth a spirited discussion on present practice of American cities in acquisition of property for public purposes. More effective control of land use, as a basis for bringing about a realization of the city plan, was urged. Throughout the meeting, the economic and social phases of planning were emphasized, and urban land policies in the United States were subjected to critical scrutiny.

Robert Whitten, planning consultant, New York, suggested a comparative study of land policies here and abroad, particularly as relating to the city plan. He suggested that such research might include:

(1) The acquirement of land for future urban expansion.
(2) The administration or disposition of such lands.
(3) The social and economic effects of such policies, including effects on the housing of the lower income classes, on land speculation, and on the costs of utilities and of municipal services.
(4) The methods employed in the taxation of real estate and the incidence and social and economic effects of such taxes.
(5) The measures of planning control exercised over private property.
(6) Any methods developed to avoid the payment of excessive awards for property taken for a public use.

The American system of platting and developing urban land was challenged in a paper presented by Jacob Crane, city planner, Chicago. Mr. Crane emphasized the evils, from a social point of view, of uncontrolled land speculation. He held that high land values, largely "fictitious," are proving to be amost insurmountable obstacles to needed replanning and rehousing schemes. Reconsideration of present urban land policies in the United States was urged.

Tracy B. Auger of Detroit discussed the reversion of lands to state or city, as a result of tax deliquency.

SOCIETY CALENDAR

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual meeting, Washington, D. C., Nov. 14-18.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, Detroit, Mich., Jan. 16-18.

AMERICAN ROAD BUILDERS ASSOCIATION, annual convention and road show, Detroit, Mich., Jan. 16-20.

AMERICAN SOCIETY OF CIVIL ENGINEERS annual meeting, New York, N. Y., Jan. 18-21.

AMERICAN SOCIETY OF MUNICIPAL ENGINEERS, annual meeting, Detroit, Mich., Jan. 16-20.

AMERICAN TOLL BRIDGE ASSOCIATION, annual meeting, Camden, N. J., Jan. 16-17.

ASPHALT INSTITUTE, Asphalt Paving Conference, New Orleans, La., Dec. 5-9.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, annual convention, Detroit, Mich., Jan. 16-18.

HIGHWAY RESEARCH BOARD, National Research Council, Washington, D. C., Dec. 1-2.

HIGHWAY AND BUILDING CONGRESS participated in by twenty national engineering societies and trade associations, Detroit, Mich., Jan. 16-20.

INTERNATIONAL ASSOCIATION OF PUBLIC WORKS OFFICIALS, Detroit, Mich., Jan. 16-18.

ENGINEERING INSTITUTE OF CANADA, annual meeting, Ottawa, Ont., Feb. 7-8.

NATIONAL ASSOCIATION OF RAILROAD AND UTILITIES COMMISSIONERS, annual meeting, Hot Springs, Ark., Nov. 15-18.

NATIONAL CRUSHED STONE ASSOCIATION, annual meeting, Detroit, Mich., Jan. 16-18.

NATIONAL PAVING BRICK ASSOCIATION, annual meeting, Detroit, Mich., Jan. 17-18.

NATIONAL READY MIXED CONCRETE ASSOCIATION, annual meeting, Detroit, Mich., Jan. 18.

NATIONAL SAND & GRAVEL ASSOCIATION, annual meeting, Detroit, Mich., Jan. 17-18.

PORTLAND CEMENT ASSOCIATION, Detroit, Mich., Jan. 16-18.

ROCKY MOUNTAIN SECTION, American Water Works Association, held its 6th annual meeting in Denver Oct. 24-26 with 94 members and guests present. A 2-day waterworks college was held in conjunction with the meeting through the cooperation of the extension division of the University of Colorado. The subjects discussed were rate structures and fire hydrant rentals, algæ control, operating experiences with ammonia-chlorine process, water pumps and pumping problems, filter sand, microscopic examinations of algæ and bacteria and bacteriological examinations of B-Coli, chemical examinations for pH, chlorine, alkalinity, etc., application of activated-carbon in water purification, rebating of bills, waterworks control by a board of public works, liability of municipalities in water-borne diseases, and financing waterworks extension through the R.F.C. Dana E. Kepner of Denver was elected chairman of the section and Benjamin E. Howe secretary-treasurer.

Obituary

HERBERT M. FULLER, former city engineer of Philadelphia, died at his home in Bradentown, Fla., Nov. 11, age 78. Mr. Fuller was appointed district surveyor at Philadelphia in 1888.

EVERETT A. HADLEY, chief engineer of the Missouri Pacific Railroad, died at St. Louis, Mo., on Nov. 11, age 53 years. Mr. Hadley was a native of Lowell, Mass., and began engineering work there in 1897, going to the Boston & Maine in 1900 as a draftsman in the engineering department. Ten years later Mr. Hadley went to the Missouri Pacific Railroad as engineer of design and assistant engineer and in 1913 was assigned to the president's office for special work on engineering projects. In 1915 he was appointed chief engineer of the railroad and continued in that position except for two years, 1918 to 1920 when he was engineering assistant to the regional director of the Southwestern Region, U. S. Railroad Administration.

FRANK W. GIBB, architect and engineer of Little Rock, Ark., died there on Nov. 4 age 71 years. Mr. Gibb was a graduate of the Missouri School of Mines and began his professional career as a mining and civil engineer but in recent years had devoted most of his time to architectural work.

SIR DUGALD CLERK, prominent British engineer, died at Ewhurst, Surrey, England, at the age of 78 years on Nov. 13. As noted in our issue last week, Sir Dugald had recently signified his inability to take over the duties of president of the Institute of Civil Enigneers because of ill health.

HENRY MAETZER, chief engineer of maintenance, Columbus Railway, Power & Light Co., died at his home in Columbus, Ohio, on Nov. 3 following a short illness. Mr. Maetzer was 56 years old. Previous to his service with the Columbus Railway, Power & Light Co. Mr. Maetzer was city engineer of Columbus for over 15 years, and previous to that time he was in private practice.

E. N. SANDERSON, member of the engineering firm of Sanderson & Porter, died at New York on Nov. 11, age 69 years. Mr. Sanderson was a graduate of Rensselaer Polytechnic Institute in civil engineering in the class of 1886 and received his master's degree in engineering from Cornel in 1887. In 1896 Mr. Sanderson associated himself with H. Hobart Porter in the formation of the firm of Sanderson & Porter and since then has specialized in public utility work.

Brief News

CLOSE TO 35,000 MILES OF HIGHWAYS were surfaced during 1931, according to a statement issued by the Bureau of Public Roads. This brings the total of surfaced roads within the state highway systems to 242,700 miles. The state highway systems have a total mileage of 328,942 and of the miles already surfaced 96,341 have a high type of pavement.

CONTROL OVER RATES charged by interstate toll bridges is sought by the Public Service Commission of West Virginia. The commission has asked the attorney general of the state to bring a test case against the company operating the toll bridge between Maryland and West Virginia at Harper's Ferry. The commission seeks to establish its right to pass upon the reasonableness of the rates charged.

USE OF GASOLINE TAX FUNDS in Baltimore will be liberalized by action recently taken by the Maryland State Road Commission. Heretofore the city has been required to use its share of the tax money for highway construction and for the improvement of arterial routes into and through the city. Under the liberalized conditions approved by the commission, the city, in 1933, can spend about $750,000 for

the installation of storm water sewers and for the acquisition of right-of-way in addition to the uses heretofore approved. This action was taken on the recommendation of Bernard L. Crozier, chief engineer of the city, because of the city's financial condition.

THE RATE OF RETURN fixed by the district court of the Southern District of California upon the property of the Los Angeles Gas & Electric Co. is questioned as to its reasonableness in a suit brought by the company to the United States Supreme Court. The district court established a rate of return of 7.7 per cent on the historical cost of the company's property and 7 per cent on its present fair value. The company asks the supreme court to invalidate this order on the ground that the rate deprives it of rights guaranteed to it under the fourteenth amendment to the constitution. It claims that such a low return amounts to taking its property for public use without adequate compensation.

A MILEAGE TAX IS placed on buses and trucks by a law passed by the Alabama legislature before it adjourned on Nov. 4 and now approved by the Governor of the state. The act covers both common carriers and contract carriers and excludes farmers, merchants, manufacturers or other persons who transport only their own property, also cooperative associations. The act provides that each operator shall pay a mileage tax ranging from ½ to 1 cent per mile for passenger vehicles and from ½ to 2 cents per mile for freight vehicles. The tax is in addition to all other fees and taxes provided by law. In the case of vehicles which do not pay the annual state license tax because they operate in interstate commerce, the tax is increased 50 per cent. It also is increased 50 per cent for vehicles which are not fully equipped with pneumatic tires.

Engineering Contracts and Capital

HEAVY ENGINEERING construction contracts reported for the past week total $19,690,000, somewhat below the weekly average for the year. State and municipal contracts of $11,704,000 compared with $31,378,000 last week, Federal Government awards of $5,319,000 compare with $8,021,000 and private awards of $2,667,000 are below the $6,869,000 reported last week.

Bridge awards include $112,000 for private bridge construction and $942,000 for public bridges. This total is slightly under the weekly average since June, not including the total last week due to the Golden Gate bridge awards. Building awards are under last week but higher than two weeks ago, industrial buildings $1,112,000, commercial buildings $1,290,000 and public buildings $3,791,000. Earthwork, irrigation and drainage awards totalled $2,660,000 compared with $3,216,000 last week. Streets and roads are up to $8,396,000.

Large awards include highway contracts let by State of Pennsylvania totalling $913,812; by Oregon totalling $1,045,787; by Minnesota totalling $962,328; by Montana totalling $900,124; and by South Carolina totalling $826,728, and a contract for lock and dam, Pittsburgh, by U. S. Corps of Engineers, $1,190,251 and $512,444 respectively.

New capital including R.F.C. is low this week. Only $1,344,000 in new bond issues is reported. The total reported to date of applications for loans approved by the Reconstruction Finance Corporation is $135,848,000. This does not include $450,000 to complete the construction of two reservoirs and the relocation of railway trackage by Tarrant County, Tex., Water Control and Improvement District, Fort Worth. Report on approval of application for this loan was received too late to include in this week's charts.

The chart has been modified on account of the reletting of the Golden Gate Bridge contracts. The original contracts were let in 1931 and were included in the contract figures for that year, but as they were relet this year they have been included in the 1932 totals and have been deducted from 1931. Another modification has been made to show approved R.F.C. loans as a separate increment to the 1932 capital figures.

Contracts and Capital

CONSTRUCTION
(Thousands of Dollars)

	Weekly Average Nov., 1931	Weekly Average Nov., 1932	Week Nov. 17, 1932
Federal government	$5,556	$6,923	$5,319
State and municipal	14,952	17,739	11,704
Total public	$20,508	$24,662	$17,023
Total private	14,182	3,857	2,667
Week's total	$34,690	$28,519	$19,690
Cumulative, Jan. 1 to date:			
1931 construction			$2,294,355
1932			1,101,064

Decrease 52 per cent.

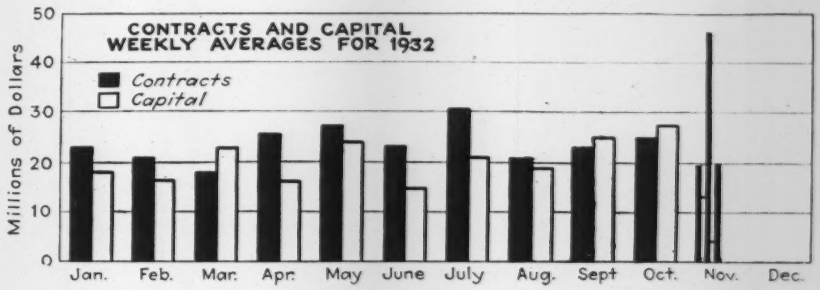
NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

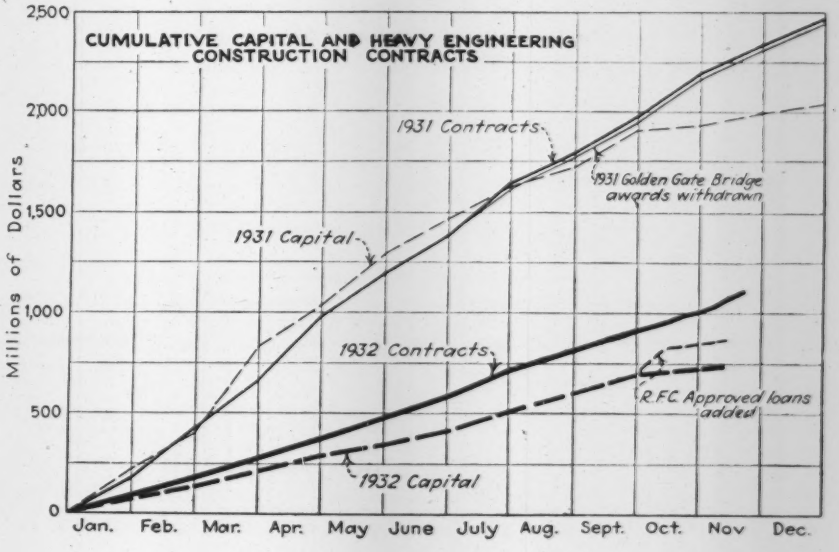
	Weekly Average Nov., 1931	Weekly Average Nov., 1932	Week Nov. 12, 1932
R.F.C. loans	.....	$5,992	$2,945
New capital issues	$17,000	1,808	1,344
Total	$17,000	$7,800	$4,289
Cumulative, Jan. 1 to date:			
1931 new capital			$1,958,000
1932 R.F.C. loans approved		$135,848	
1932 new capital		727,985	
1932 total			$863,833

Decrease, 56 per cent.

ENR Cost and Volume Index

Cost		Volume	
November, 1932	**158.20**	**October, 1932**	**137**
October, 1932	159.16	Sept., 1932	124
November, 1931	169.28	October, 1931	229
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.85	1930 (Average)	260
1913 Average	100.00		

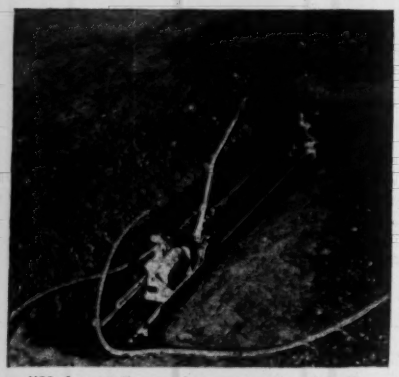




Construction Equipment and Materials

Earth-Boring Auger for Installing Water Pipes

A horizontal earth-boring machine designed to install water pipes without opening a trench from the surface is being manufactured by the Hydrauger Corp., Woolworth Building, New York, N. Y. The machine operates from a small pit dug to the depth of the proposed pipe line. An air motor drives the auger through a shaft to which are added lengths as the boring proceeds. The material loosened by the auger is washed back by water fed from adjustable jets. A suitable distance behind the auger itself are the cutting tools and spiral which enlarge the hole. The boring bars or shafts are hollow to carry the water away.



"Hydrauger" permits water pipe installation without requiring trench.

Two sizes of machines are produced, one having a pilot bit 2½ in. in diameter and the other 5 in. Reamers are provided which will enlarge the hole made by the smaller machine to a 5 in. diameter and that of the larger machine to a 10½ in. diameter.

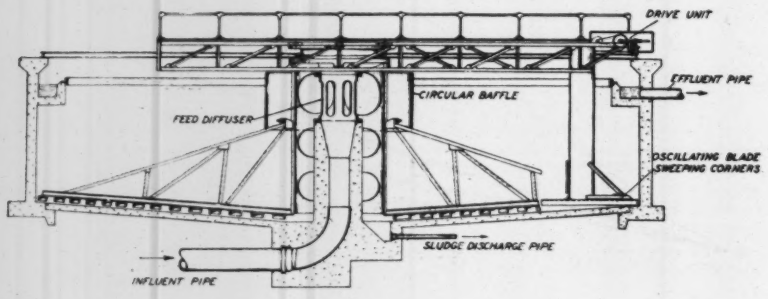
Improved Entrance Design For Dorr Sedimentation Tanks

A new and improved method of feeding its sedimentation units, to be known as Sifeed, has been developed by the Dorr Co., Inc., and will be offered from now on for use with both the square Dorr traction clarifier and the round Dorr central drive clarifier. The distinctive features of this new method are the introducing of the influent through a centrally-located, inverted siphon and the overflowing of the clarified effluent across the peripheral weir extending around the entire inside of the tank at the water level.

The influent pipe passes under the bottom of the tank in a radial direction and terminates at the base of the central pier in a long radius elbow. The central concrete pier is cored out directly above this elbow, forming a vertical conduit, flared out at the top, for carrying the influent into the base of the feed diffusing casting.

The sides of the tank, either square or round, are provided with a continuous, peripheral effluent weir at the water level, making it possible to collect the effluent around the entire top of the tank. The clarified effluent flows into a peripheral channel, arranged to discharge at any convenient point.

Dorrco Sifeed settling tanks



New Equipment in Brief

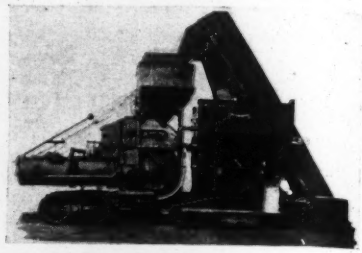
Chemical Feeder. A special feeder for ferric chloride, known as the "Tret-O-Motor" is announced by Proportioneers, 77th and Avalon Ave., Chicago, Ill. The proportioning device is driven by a rope and pulley connecting it to the variable-speed shaft of the sludge pump. A gear reducer slows down the device from line shaft speed to practical pumping speed. The reducer unit drives an eccentric and connecting rod which flexes a rubber diaphragm pump a number of times per minute in proportion to the sludge pumping. All parts in contact with the ferric chloride are of rubber.

Truck Mixer. A new 5-yd. Rex motomixer is announced by the Chain Belt Co., Milwaukee, Wis. As a truck mixer this unit handles 5 cu.yd. of mixed concrete or 7 cu.yd. when used as an agitator. The drum has a three-point suspension with the forward end riding on a single SKF ball bearing, and the rear end on two Timken rollers. The mounting is such that the drum rides between the sills with a low center of gravity. The discharge can be controlled through a hand wheel and worm and gearing reducing unit. Both mixer and agitator units are driven by independent motors equipped with electric starters connected to the truck battery. All controls are located at the rear of the machine to facilitate discharging.

Bituminous Paver and Finisher Now a Three-Unit Machine

The Barber-Greene Co., Aurora, Ill., announces that its bituminous paver and finisher is now being manufactured as a three-unit machine. What was previously the paver is now two units consisting of a special loader as the first unit and the mixer as the second unit. The finisher is practically the same as before with the exception of minor improvements.

In the new design the loader is provided with two tanks for carrying a supply of oil or asphalt. The loader is further supplied with a transmission of wide variety of speeds. The mixing unit is attached to the loader by means of a king pin and trails on its own wheels. It is supplied with an 82-hp. power plant. A positive-feed pump takes the oil or asphalt from the loader tank and delivers it to spray nozzles in a spray chamber. A storage hopper on top of the mixer receives the aggregates discharged from the loader. The finisher spreads, compacts and screeds the mixed material.



Barber-Greene's new bituminous paver

New Drafting Machine Capable of Fast Work

An improved drafting machine is being manufactured by Charles Bruning, Inc., 818 Santee St., Los Angeles, Calif. Its maker estimates a saving of 25 to 40 per cent of drafting time, coupled with greater accuracy than when using ordinary methods. The unit may be pushed out of the way to leave the top of the drafting table free. It is ball-bearing equipped throughout. The working radius of the standard size unit is 44 in. Tube arms are 19½ in. long. The clamp or anchor is designed to be used on any edge of the board.

Business Notes

THE INDUSTRIAL TRADING CORP. has been formed by Louis M. Vidal, president, and V. D. Demarest, secretary-treasurer, with offices at 227 Fulton St., New York, N. Y. The new company will represent certain American manufacturers for the New York district with special attention to export trade.

ROBINS CONVEYING BELT CO., 15 Park Row, New York, N. Y., has opened new sales offices at Cleveland, Detroit, St. Louis, and Charleston, W. Va. These offices are in addition to the branch offices in Pittsburgh, Philadelphia and Boston.

L. J. MILEY CO., 1462 South Michigan Ave., Chicago, Ill., manufacturers of Ebonite brake lining, has announced that Eugene M. Miley has been elected head of the concern to succeed the late L. J. Miley.

KEYSTONE DRILLER CO., Beaver Falls, Pa., announces that H. H. Elmire, who has been in charge of the New York district office at Arlington, N. J., has been promoted to field engineer of the company. James Shearer has been selected to take his place as district manager at Arlington.